# ARMY ORDNANCE

VOL. XXVI, No. 142 JANUARY-FEBRUARY, 1944

## Ordnance Firepower in Battle
Maj. Gen. Levin H. Campbell, Jr.

## Education in Armament
Brig. Gen. H. R. Kutz

## Production for Victory
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## Overseas Repair of Military Tires
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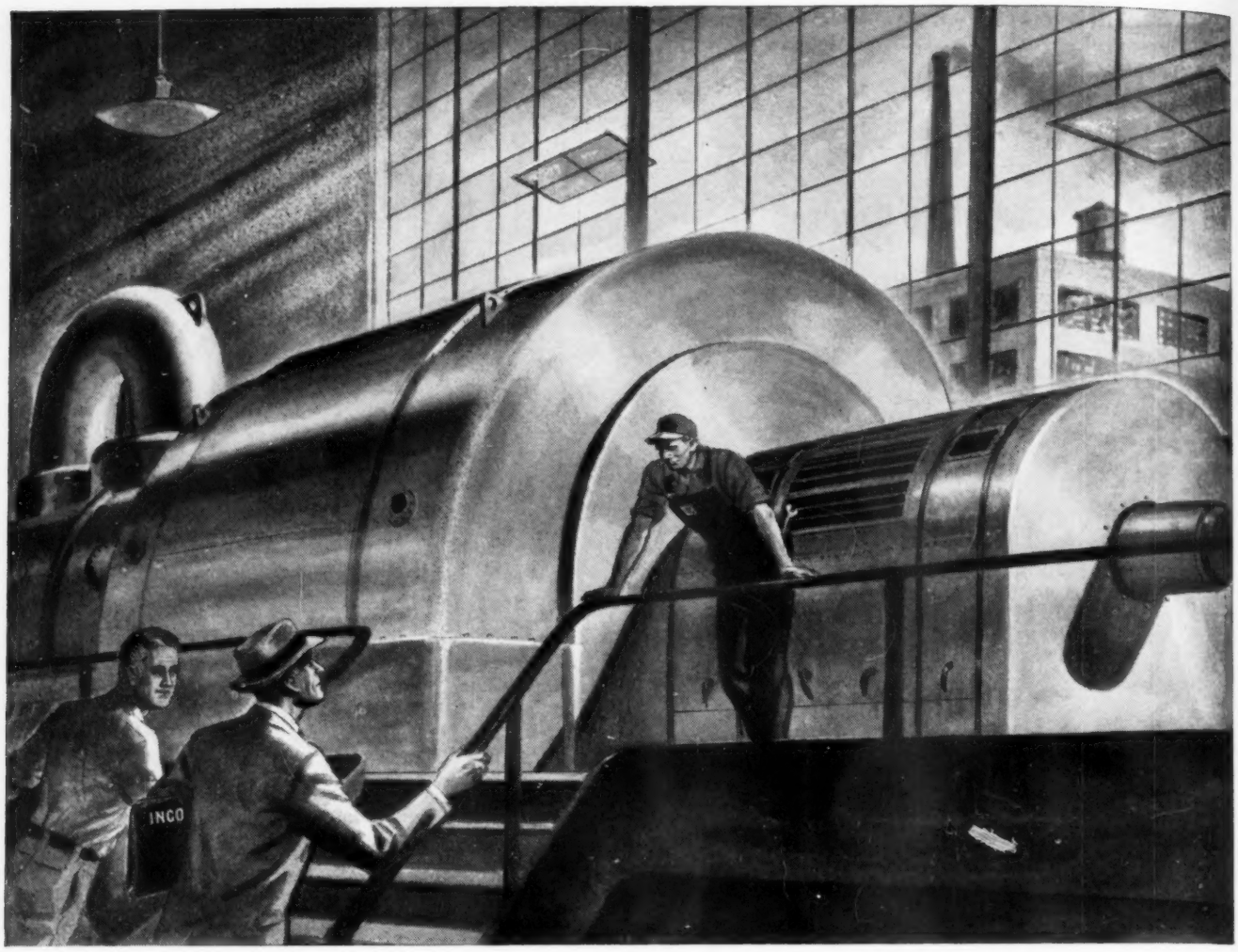
## Augusta Arsenal
Col. Gregory S. Lavin

## After the Tank, What?
Col. H. W. Miller

A REVIEW OF INDUSTRIAL PREPAREDNESS FOR NATIONAL DEFENSE
PUBLISHED BY THE ARMY ORDNANCE ASSOCIATION, WASHINGTON, D. C.

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# ARMY ORDNANCE

THE JOURNAL OF THE ARMY ORDNANCE ASSOCIATION

*Founded 1920*

For Victory through Armament Research, Production, and Supply

Volume XXVI JANUARY-FEBRUARY, 1944 No. 142

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# THE ARMY ORDNANCE ASSOCIATION

## The Aims, Purposes, and National Officers of the Society

THE Army Ordnance Association, a national society of over 16,000 American citizens, was founded in 1919, "pledged to industrial preparedness for war as our nation's strongest guaranty of peace." The society was incorporated under the laws of the District of Columbia in 1928. Its entire energies are now dedicated to victory for the armed forces of the United States. For the duration of the war it is "pledged to victory—complete, absolute, final."

The Association has endeavored during the past twenty-four years to keep alive an interest in and knowledge of the design, production, and maintenance of military armament. This it has done through periods of public lassitude and times of great national emergency. Until 1940 there was no peace-time armament industry in the United States for the production of ordnance. Now all American industry is geared for victorious war production.

The principal objective of the society is an active membership of American citizens to assist in the design, development, procurement, production, maintenance, and supply functions of the Ordnance Department of the United States Army. When peace returns, this body of informed citizens will again continue to be a bulwark of knowledge, experience, and ability upon whom the Armed Forces of the United States can rely for technical and scientific assistance and for industrial preparedness.

The Association is devoted solely to the national defense; it has no commercial interests, no political alliances, and no religious affiliations. It is not operated for profit: its income is expended in furthering its aims. Its elected officers and directors serve without remuneration. Membership, to which American male citizens are eligible, is four dollars a year. (Application facing p. 112.) There are twenty-two local chapters of the Association throughout the United States.

ARMY ORDNANCE, the journal of the Association, is published solely for the purpose of disseminating information on the progress of our munitions developments so that American industry may at all times know its responsibilities to the common defense.

The objectives of the Association as set forth in its Constitution are:

To assist in effecting industrial preparedness for war as being one of the nation's strongest guaranties of peace;

To keep available the highly specialized knowledge necessary for arming the manhood of the nation by stimulating interest in the design and production of ordnance material;

To promote mutual understanding and to effect coöperation with American scientists, inventors, engineers and manufacturers in civil life and the Regular and Reserve officers of the Ordnance Department;

To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

To commemorate the services rendered by the industry of the nation and by the officers and civilian employees of the Ordnance Department in the wars in which the United States has been engaged.

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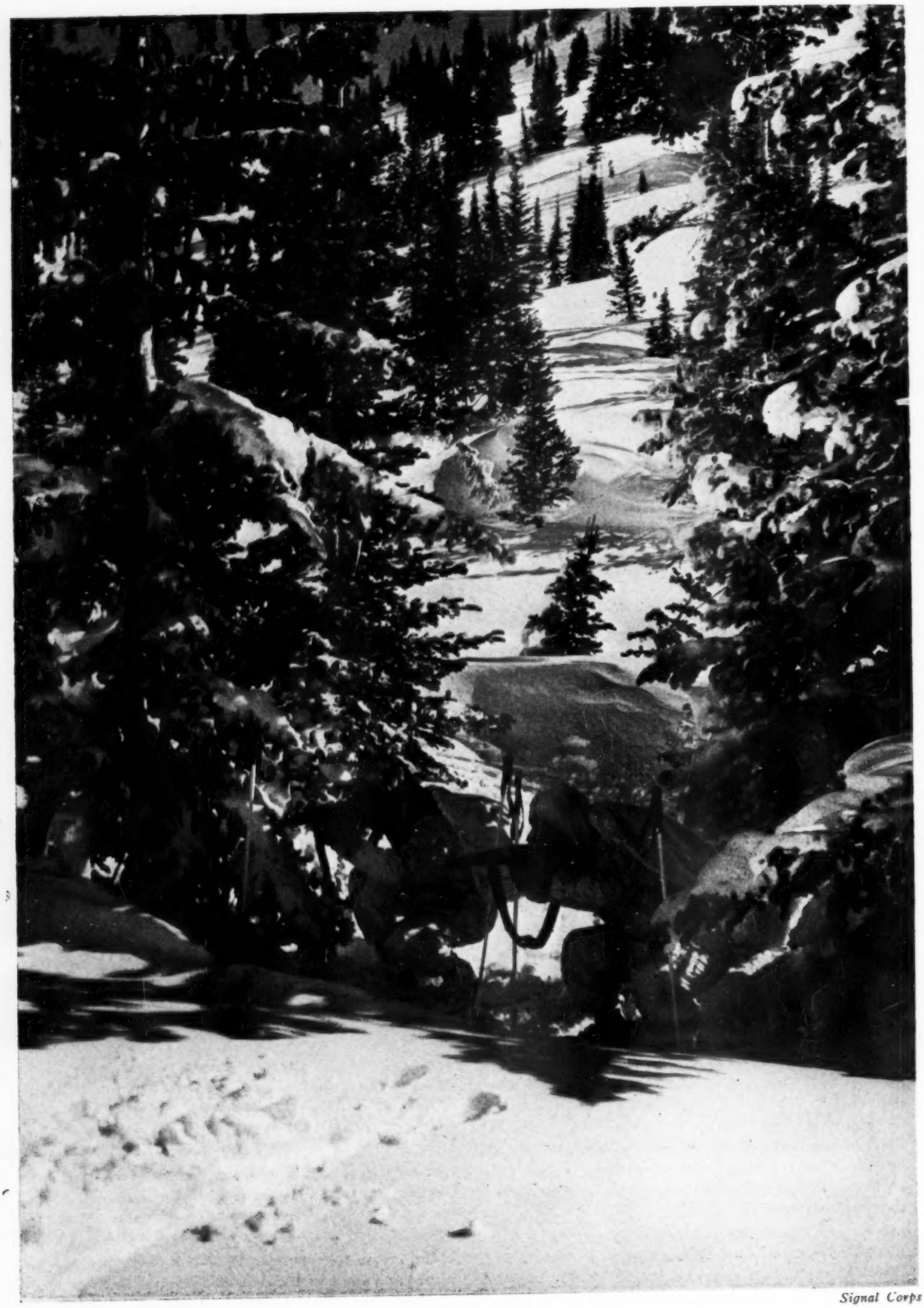

*Signal Corps*

Ski Patrol

ARMY ORDNANCE

Volume XXVI JANUARY-FEBRUARY, 1944 No. 142

# Ordnance Firepower in Battle

## Weapons of the Industry-Ordnance Team Meet the Test of War

Maj. Gen. Levin H. Campbell, Jr.

THIS is the first time I have had the pleasure of meeting with the members of the Detroit Post of the Army Ordnance Association. It is an occasion I have looked forward to with keen anticipation for a long while. It affords an opportunity to talk with friends of the Ordnance Department whose counsel I have sought many times during the prosecution of this war and also during the many years of my service in the Department preceding this war. As a charter member, I salute you all as fellow members of this great Ordnance society for your steadfastness through the years.

Many of you gentlemen have led the forces of industrial preparedness during the past quarter of a century. Many of you, as members of this great technical and scientific society, have rendered service to your country which ranks among the greatest of industrial and patriotic achievements.

The Army Ordnance Association, founded at Aberdeen Proving Ground this month twenty-four years ago, is a tower of strength to this Nation. It has never been operated for profit to any one. It has loyally maintained its one great goal of industrial preparedness, and has never permitted itself to deviate from that goal. Time and again when conditions arose to distract its attention from the one basic problem of industrial preparedness, your society has always stood by its guns. Yes, a tower of strength! Let us build it ever higher!

Today, every tenet you have upheld and every principle you have defended are part of the accepted doctrine for winning this war. With deep sincerity, I say that I know of no group of men the world over that surpasses in service the quiet, unassuming, yet vital work, of the executives and engineers of American industry who compose your membership. In all humility, as Chief of Ordnance of the Army of the United States, I say to you that without your abiding support the Ordnance responsibility in this war would at times have been well-nigh impossible of fulfillment. My heartfelt thanks to you—one and all.

MY THANKS also to you of Detroit for your coöperation with the Detroit Ordnance District and the Ordnance Tank-Automotive Center. Both are vital cogs in our fast-moving Ordnance organization. The Detroit Ordnance District, under my friend Brig. Gen. A. B. Quinton, carries a gigantic responsibility. This district office administers all Ordnance procurement in this area. As a unit of our Ordnance district system, it is one of our thirteen industrial regions and it gives hourly proof of the importance of the close coöperation of industry and the Ordnance Department, not in the method of the military, but in the best practice of American industry.

My thanks also for your coöperation with the Ordnance Tank-Automotive Center, under the command of that industry-minded Ordnance officer, another old friend, Brig. Gen. Walter P. Boatwright. This Center, here in the automotive capital of the world, is responsible for all automotive operations of the Ordnance Department. Here again is a fine object lesson of the Industry-Ordnance team in operation. I commend its work to all Americans, as taxpayers, as another example of efficiency and economy while winning a war.

HERE in Detroit you have, also, a very remarkable Ordnance depot at Fort Wayne. It has a long and inspiring history. Today, it is a most important cog in furnishing ordnance equipment to our forces. I congratulate its commanding officer, Col. Ray M. Hare, and all the members of his staff, military and civilian. The Fort Wayne Ordnance Depot is a real credit to the Army of the United States as it is also to the great city of Detroit.

I propose to speak to you about Ordnance firepower in battle. From September 1939 until only a few months ago, whenever we have met to plan, to build, to operate, to supply, and to service fighting equipment for our armies and those of the United Nations, the results to be gained were dreams. The reality of those plans was yet to come. For nearly four years now, you of industry and we of the Ordnance Department have met together under conditions of dire urgency to plan for the arming of our forces.

We came to you with well-considered armament designs and a spirit of coöperation. You came to us with the tremendous power of American industry and placed it at our disposal. We had a few up-to-date guns and you, dropping every other consideration, took up the task of the armorer. We had not nearly enough automotive weapons and you, foregoing a gigantic civilian automotive industry, instantly left that field to give us promptly the greatest array of the strongest mechanized firepower the world has ever known. We had little powder, a pittance of explosives, scarcely any bombs. Our ammunition magazines were nearly bare. Our small-arms production was trifling by current standards. We were sadly deficient in everything except sound engineering design, a few pilot models, a half-dozen arsenals which had been starved for decades.

But you in Detroit, typical of American industry throughout the land, gave all your effort, your knowledge, and your great industrial resources to our war production. You are doing that tonight in your plants and factories, and you will continue to do it until final victory is ours. There can be no letup. Ordnance production, month by month, gives ample evidence that there is no letup. In some of our plants, produc-

General Campbell is Chief of Ordnance of the U. S. Army.
This is an address delivered at the fall meeting of the Detroit Post of the Army Ordnance Association, held at the Book-Cadillac Hotel, Detroit, Mich., October 27, 1943.

tion has attained almost unbelievable goals. Management is applying all the controls for which the Industry-Ordnance team is known. Those controls must be continued!

Efficiency of operation and economy are still guiding principles in our progress. We must be careful of the taxpayer's interest and we must weigh every dollar of expenditure of Government funds as carefully and zealously as though they were our own. As the demands from the battle fronts change, so also must we meet those changes instantly.

Our ordnance-production curves are up; our man-power curves are down. Our unit-cost figures constantly grow less. The Ordnance dollar, day by day, shows an increasing return, not only to the man on the battlefield, but to every American taxpayer throughout the land. Such goals are basic in our Industry-Ordnance operations, and they will continue to guide our course throughout this war.

The Ordnance Department has been in this business of coöperating with American industry in producing weapons for 131 years. The Army Ordnance Department learned the meaning of efficiency and economy seven major wars ago!

I WILL now discuss briefly six of our principal items of ordnance. The weapons chosen are typical; they are only six out of hundreds I might have chosen! I want to mention briefly what each of these is doing on the world battle fronts, for the greatest of all armament tests comes in the proving ground of war. How are our weapons meeting the test? The answer is simple: Our ordnance has outclassed our enemies' and has beaten back the Axis forces constantly in all theaters of operation. That's by the record!

The first battle report I present concerns the well-known Garand semiautomatic rifle. The Garand is conceded to be the world's foremost shoulder rifle. It increases the firepower of the individual soldier as much as three times that of our former standard shoulder weapon. There were production difficulties connected with the Garand, but they were quickly overcome. So true is this that we will soon have produced—maybe we are producing it at this very hour—the two millionth Garand. The present production rate could have equipped with Garand rifles our entire 1939 Regular Army—every man of it—in a month and a half! What do the battle reports say about the Garand rifle?

*From Attu:* Three Japanese soldiers charged one American infantryman. He killed all three Japs with his Garand, a feat which, under the same conditions, would have been impossible with a bolt-operated rifle.

*From Guadalcanal:* The Japs thought our Marines were still using the bolt-action Springfield. They would wait until the Americans had fired five shots, having in mind the 5-round clip of the Springfield. They would then rush a position. The extra three rounds in the semiautomatic Garand 8-round clip mowed them down constantly.

*From Sicily and Salerno:* The Garand proved invaluable in the tough close-in combat that characterized those operations. The Garand has won added laurels. It has made the American infantryman supreme in battle, thanks to brave fighters and the Industry-Ordnance team.

Next, I report upon the caliber .50 aircraft machine gun. I quote that great soldier and strategist, Gen. H. H. Arnold, Chief of the Army Air Forces, in a recent statement on this gun [see ARMY ORDNANCE, September-October 1943, Vol. XXV, No. 140, p. 317]: "With foresight, the Ordnance Department had the caliber .50 aircraft machine gun ready for use. This gun weighs only 64 pounds and can discharge up to 800 projectiles a minute at a velocity of 2,800 feet a second. Our present airplanes are literally bristling with these guns. In fighters, you will find four, six, and more fixed in the wings or fuselage.

"The outstanding small-arms development for use against airplanes," General Arnold states, "was the incendiary caliber .50 cartridge. The most vulnerable part of a modern airplane is the gas tank. With the advent of the self-sealing gas tank it was found that tracer ammunition was ineffective for setting aircraft on fire, so caliber .50 incendiary projectiles were introduced. These, fired in conjunction with armor-piercing bullets, made the caliber .50 the best gun for airplanes to date." That is high praise from the Chief of the Air Forces, and we are grateful for it.

Now let me cite one incident concerning this gun from battle operations in Sicily. One of our bombing squadrons on July 5th undertook a mission to bomb an airdrome on that island. Five minutes before reaching the target the squadron was attacked by twenty-five enemy aircraft which came in singly, in pairs, and, in one or two instances, in groups of four. The visibility was excellent, and the sergeant who manned the gun to which I refer held his fire while tracking the attacking aircraft until the range was between 100 and 300 yards. He continued to fire until the attackers were either out of range or had been shot down. Approximately 100 rounds were fired on each attack for a total of 1,200 rounds.

I now quote the battle report verbatim: "As a result of the excellent gunnery of Staff Sergeant Warmer and the perfect functioning of his weapon, a total of seven German aircraft were officially credited to him—three ME 109's, one ME 110, one FW 190, and two unidentified fighters, believed to be ME 109's." That particular gun was made here in Michigan. Its serial number is 455797. It was still in use functioning perfectly, constantly in battle two months after the above engagement.

NOW, a brief reference to bombs. The terrific devastation wrought by American bombs is evident in each daily paper and in the magazines and newsreels. Every American bomb is produced by the Industry-Ordnance team. Just as Ordnance furnishes the caliber .50 gun for aircraft, so it furnishes all the bombs of all sizes for our American military bombers, and many of those of our allies.

One of our Ordnance officers, Col. S. P. Huff, received the Legion of Merit citation recently for his contribution to the development of a new bombing technique known as "skip bombing." It was largely responsible for the victory of the Bismarck Sea.

Brig. Gen. U. G. Ent, Commanding General of the Ninth Bomber Command, which on August 1st bombed oil refineries in Rumania, reports that the Army Ordnance contribution to this spectacular raid was truly magnificent. Six out of seven targets were hit solidly in the midriff by skip-bombing technique. The seventh target was not hit because the navigator for the leading planes was killed before the target was reached. Some of the Ordnance bombs had special delay-action devices. According to General Ent, "They were still exploding two days after the raid."

In a recent 45-minute raid on Hamburg, Germany, Flying Fortresses unloaded 5,152 tons of assorted blockbusters. You have read of the results. That much commercial explosive would make available a month's supply of coal in the United States. The Industry-Ordnance team produces the bomb, the fuze, and the high explosive!

Here is one more report, this time on parachute bombing in the Battle of New Guinea. I quote the words of an observer: "As the Japanese were crossing the Owen Stanley Range attempting to take Port Moresby, every type of combat possible was waged against them, but the one thing they could not contend with was the fragmentation bomb. Dropped against front-line infantry and against the lines of communication, the bombs kept the troops and pack trains off the trails, forcing them to be without food and water. There are many examples of airdromes, supply trains, and encampments cut to pieces by these bombs." Once more—thanks to our gallant airmen, the men and women who make the airplanes, and to the Industry-Ordnance team.

NEXT, I cite the battle performance of our 105-mm. howitzer. It is called the "workhorse of the Army." From the Alaskan Defense Command comes the following: "The 105-mm. field howitzer, despite almost 'round-the-clock firing in wet weather with no time for usual maintenance except an occasional bore swab, functioned without difficulty and maintained its long-range accuracy. Nearly 8,000 rounds were fired by two batteries during a 24-hour period. The long range and accuracy of the 105 made it possible to give support to the infantry without being moved from original positions before the target became almost impossible during the 3-week battle."

From a British report: "This 105-mm. howitzer is in our belief the best piece of light field artillery in the world. It compares favorably with the British 25-pounder; it throws a shell eight pounds heavier with almost three times as much high explosive in the shell."

In the final campaign of Tunisia, the II Corps of the United States Army lost only one field-artillery piece. According to Lieut. Gen. Omar N. Bradley, commander of the II Corps, all other artillery pieces were kept in fighting trim by Army Ordnance combat mechanics.

Now I cite for special honors that worthy companion of heroes, "Long Tom." That is the familiar name given to our 155-mm. gun. "Long Tom" is leading Lieut. Gen. Mark W. Clark's steady drive up the Italian peninsula. This hard-hitting gun blasted Rommel in North Africa, bombarded Tunis and Bizerte, helped drive the Axis out of Sicily in thirty-nine days, and fired the first projectile from Messina to the mainland.

Forty-eight hours after the Marines landed on Rendova Island in the Southwest Pacific, a row of "Long Toms" was pouring a steady stream of fire into the Japanese on Munda, eleven miles away.

Equally at home in the desert, the jungles of New Guinea, and the mountainous terrain of southern Italy, the sharp-shooting "Long Tom" is daily winning new laurels against the enemy. Its accuracy is so astounding that a crossroads in one engagement was kept constantly under fire from a gun position more than ten miles away. On the Tunisian front, a battery of 155's destroyed a German battery more than 20,000 yards distant. That's the kind of shooting we of the Industry-Ordnance team like to see.

And now final honors are reserved for Detroit's own M4 tank. First, I quote no less a military strategist and tactician than Mr. Winston Churchill, Prime Minister of Great Britain, who this month a year ago hailed our American tanks as "destroying enemy tanks at ranges up to 2,000 yards." From a British major general in the Middle East came this report: "The American M4 tanks have made a great impression on every one and the troops are thrilled with them. The long gun is magnificent both in accuracy and penetration."

From another British source: "British prefer American medium tanks to any other tank."

And from the diary of a captured German: "Tommy is using an American tank which has incredible armor and very good armament."

AT the Battle of Salerno, eight Army Ordnance tanks, survivors of a terrific hail of fire from German 88-mm. guns encountered before they even got ashore, shot their way up the beaches of the Gulf of Salerno and had a big rôle in beating off the first German counterattack on the American beachhead a few hours after the raid. Every battle in Africa and in Europe has testified not only to the bravery of our fighters but to the excellence of our tanks. For Detroit's leading part in that record, I salute and thank you all.

For reasons of which you are well aware, I am unable to go into detail on many of these matters. What I have said, cautiously and with circumspection—for enemy ears are ever alert—gives positive proof in my judgment, and I hope in yours, that the products produced by the Industry-Ordnance team are fitting companions for the heroism of the most gallant fighters modern war has known. What our American boys are doing on battlefields around the world is an epic of courage, fidelity, heroism, and patriotic devotion. Nothing of metal or explosive that we have ever produced can match or even approach the valor of these heroic fighting men.

As their deeds of heroism multiply, our responsibility likewise increases. Thus far you have met that responsibility by designing and producing in quality and quantity the armament with which such noble victories are won. No American soldier, whether he be in the fogbound Aleutians, the jungles of the South Pacific, the shores of the Mediterranean, or the trails of the Far East, can ever for a split second doubt the superiority of his weapons or that they will bring him victory.

Your obligation and mine is to our fighting men and those who are near and dear to them. Long ago we pledged ourselves not to fail the mothers and fathers of our American boys in this great obligation. We have kept the faith! We of the Industry-Ordnance team will keep that faith against all odds until the last battle is won and our glorious boys come home victorious.

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EDITOR'S NOTE.—Writing on "Firepower for Victory" in the May-June 1943 issue of ARMY ORDNANCE (Vol. XXIV, No. 138, p. 493), General Campbell said: "We Ordnance engineers stand, above all, for firepower. We know that it is not the size of a tank or the width of a gun carriage that destroys the enemy. We know rather that the amount of steel and high explosive we can deliver at the enemy target is what will win battles and eventually will win this war. So we in Ordnance urge that we keep ever before our minds the one word 'Firepower.' We engineers express it in another way by a simple mathematical expression—$\frac{1}{2}MV^2$—where $M$ is the mass of the projectile and $V$ is the velocity. You can readily see from this that if we have projectiles or bombs of the greatest possible mass and of the highest reasonable velocity we are bound to deliver at the target the greatest destructive effect. Let no one doubt that your Ordnance Department stands for *firepower* which, in turn, stands for destruction of our enemies and certain victory."

# Education in Armament

## The Task of the Ordnance Military Training Division

Brig. Gen. H. R. Kutz

SOME ONE once said, in effect, that given a log with an instructor at one end and a student at the other he would have the beginning of a university. The gulf which exists today between that conception of education and the training of an Ordnance soldier only serves to emphasize the magnitude and complexity of the task with which the Military Training Division of the Ordnance Department has been faced during the past fourteen months.

Modern battlefields are maelstroms of men and machines—a multiplicity of machines of a complexity hitherto undreamed of in warfare. Airplanes, tanks, combat and transport vehicles, self-propelled and antiaircraft artillery, together with their fire-control equipment, are all machines designed to provide the maximum mobility and firepower needed to kill enemy soldiers.

The rôle of the Ordnance Department is to design, develop, procure, store, issue, and maintain the machines and weapons with which the American soldier fights. To win battles, military machines must at all times be capable of operation at maximum efficiency. Being machines, they are susceptible to wear and tear, malfunctioning, and unserviceability due to normal use, and are vulnerable in varying degrees to enemy action. The combat soldier is carefully trained in the operation and tactical use of his weapons, but has neither the tools, the time, nor the specialized skill required to repair them when damaged or when in need of major adjustment or overhaul. Therefore, there have wisely been provided Ordnance units of various types, composed of technically trained soldiers especially skilled in maintaining the fighting man's weapons and transport and in the supply of combat essentials, such as spare and repair parts, tools and accessories, cleaning and preserving materials, and ammunition of all types.

This does not take into account the broader aspect of transforming the individualistic citizen into the trained and disciplined soldier, the problem of indoctrinating him as to why we fight, the building up and sustaining of his morale—all of which are important, yes, vital, factors in his education and training.

The Military Training Division of the Ordnance Department has been charged with the tremendous task of training several hundreds of thousands of Ordnance officers and enlisted men, first to be real soldiers—for that is fundamental—and then to become highly skilled specialists and expert technicians fully qualified to perform the vital Ordnance mission of supply and maintenance of all ordnance matériel in the various theaters of operation. To understand better the present training situation, it may be well to consider briefly the pattern of Ordnance training prior to mobilization.

The Ordnance Department in peacetime maintained small schools with a capacity of only several hundred students at Raritan Arsenal, N. J., and at Aberdeen Proving Ground, Md. Normally, students were specially selected, above-average, experienced soldiers. Time was not an important factor. Instruction was somewhat leisurely, with courses extending over varying periods of from nine months to a year. Little detailed planning was required. Courses covered practically everything there was to be taught about a particular subject. There were few training aids—the weapon or item of equipment itself was usually available. There were few instructors' guides, as the knowledge to be imparted to the students was contained in the minds and experience of a comparatively few veteran instructors.

Schedules were quite flexible. A master sergeant, for example, instructing an ammunition class in the intricacies of time fuzes was not unduly concerned if his students did not promptly grasp the principles involved, for it was possible to resume discussion on the following day or for several days thereafter, if need be. There was also time, perhaps, to visit a manufacturer of fuzes and to see at first hand how they were made. There was even time to delve into the history of the development of fuzes—information not essential to the functioning, storage, or handling of a fuze, but well to know, nevertheless. In other words, our training in those days proceeded at a pace and with a scope traditionally familiar in the academic field. We covered the subject fully and were not greatly concerned about the length of time required.

Pearl Harbor and subsequent rapid mobilization changed all this. From the factory, the farm, and from business and the professions, thousands of men, instead of the dozens we had previously trained, poured into our inadequate facilities. It was our job to convert them into highly skilled Army specialists—experts in tank engines, skilled optical repairmen, ammunition handlers, artillery mechanics, storage and supply experts, or bomb-disposal technicians, to cite only a few. Recruits were chiefly men with no outstanding technical, military, or combat background (except, perhaps, in the automotive field)—thousands of them—who had to be transformed into soldier-technicians in an incredibly short period of time.

THE fantastic increase in the number of trainees and the limited time available were only two factors. There were many additional difficulties and problems. The proportion of students to instructors was at first hopelessly top-heavy. This involved the selection, development, and training of many instructors together with current training of inductees. The proportion of students to items of matériel available for instructional purposes was far out of line. This required development of new training aids of various types to substitute for scarce equipment. The technical lore contained in the minds of our veteran instructors had to be transferred to printed instructors' guides. There was the matter of the number of students in relation to the time element and the resulting overtaxed classroom capacities. To do the training job in the time allotted we needed vastly increased physical plants, the building of which must proceed apace with training.

Over all was the handicap of a lack of technical and military background, previous experience and knowledge on the

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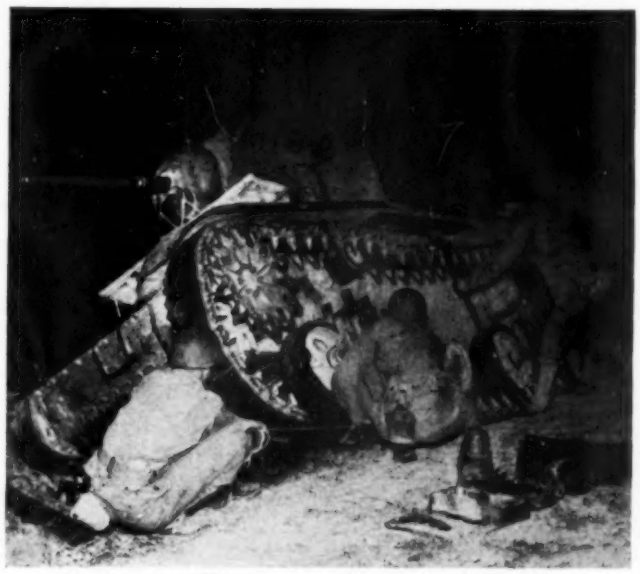
part of these men from the farms and the offices—a lack of prerequisites which previously were thought to be quite necessary in the training of Ordnance technicians. We had to consider, too, that many of our students were involuntary students; that is, they had to be made proficient in skills in which originally they had no particular interest. They were about to get for the first time in their lives some real, honest-to-goodness, concentrated training.

Obviously it was not going to be possible to train these thousands of men using the methods we had employed in the past. The immediate solution was to be found in a single basic word—*planning*—intelligent planning. It was at once evident that we would have to get along for some time as best we could with the buildings, quarters, and classrooms available, using tents and open-air instruction in many instances, until suitable construction could be provided. But we could, and did, immediately get busy to revamp the subject matter which we were teaching.



REPAIRING A TANK UNDER BLACKOUT CONDITIONS

Representing the information to be taught as a target, we can divide it into three categories: (1) "must-know" information, (2) "should-know" information, and (3) that which is "nice to know." Before mobilization we fired at this target with a shotgun; that is, we taught practically everything. The skilled Ordnance mechanic was a Jack-of-all-trades with a knowledge of small arms, machine guns, artillery, fire-control instruments, and ammunition. After mobilization, it was apparent that instead of blasting away at the whole target with a shotgun we were going to have to use a rifle with telescopic sights and concentrate only on the bull's-eye—the "must-know" information. The problem, then, was to select carefully from the mass of detail we had been teaching only those elements which could properly be labeled "must-know," and design clear, concise, highly streamlined new courses of instruction.

IN like manner, change was found necessary in the proportion of practical work to schoolroom theory. Our peacetime courses of instruction were composed approximately half of practical work and half of the study of principles and related information. It has now been found advisable, however, to spend, in most instances, as much as eighty-five per cent of the technical training time in actual practical work; hence, classroom theory—principles and related information—had to be condensed drastically. The end result to be obtained and the quickest, most efficient direct means to that end, must be ever uppermost in our minds.

We recognized the necessity for, and quickly adopted, many of the methods used in the training schools of the large automobile manufacturers and in the trade schools. The essence in many technical courses was to teach men what actually happened without necessarily teaching them why it happened. Let us take a munitions worker, for example. Assume that a man had a basic general education. We could teach him ever so little about chemistry, metallurgy, mechanics, electricity, and economics, but we *must* teach him a great deal about how to store, handle, and ship explosives, about safety measures, about traffic control, about accounting. Thus, while he *must* know what would happen if he failed to handle ammunition properly, he would not necessarily have to know exactly why the results of his failure would be so disastrous.

We had to train bomb-disposal men. We had never had the problem of bomb disposal before; therefore, we had to assemble the information and disposal methods to be taught, gleaned from the recent experiences of our allies, and train men who knew little about the chemistry of explosives to dispose of bombs safely and efficiently. Military training, discipline, and leadership are, of course, essential to, and effectively help to support, the structure which we have erected.

There were still two other vital considerations—the initial shortage of weapons and items of equipment available for training, and the length of time required to give students basic instruction on the item of matériel itself. One instructor, using one rifle, can be expected to acquaint perhaps six students with the essential preliminary data about this complicated item. By preliminary is meant that explanation of ordnance matériel—tanks, guns, etc.—about which every Ordnance soldier must know something. But with the use of training aids—such as moving pictures, film strips, charts, working models, sectionalized weapons, or assemblies and the like—one instructor, using no matériel, can give preliminary instruction to large numbers of men at any one time. Subsequently, of course, specialists do receive detailed instruction on the matériel itself, usually in groups of from six to eight students.

The imperative necessity for turning out as our end product in a very minimum of time a thoroughly trained, highly skilled specialist—not a Jack-of-all-trades—precluded the possibility of permitting our courses of instruction to continue to develop as an evolutionary process over a protracted period, during which time many changes in training equipment, visual aids, and teaching procedure could continually be made to improve training and approach the ideal. We believed it to be absolutely essential to design our highly technical courses of training to meet specific, well-defined objectives. Our aim was to produce a particular type of technical skill by the most direct methods without the inherent delay in normal evolution and without waste of precious time, effort, and training facilities.

The approved solution appeared to be creation of what might be termed "prefabricated" courses of technical instruction designed to accomplish specific missions. This means simply that we started with the end product ever in mind and built our course of instruction to provide that product.

It was a definite change in the method of approach in planning our instructional program. Instead of defining a course of instruction in terms of subject matter to be taught, we attempted to define it in terms of the specific end results the trainee was expected to achieve and of those measures and procedures necessary to accomplish this. We wanted a specific product rather than a course of study. Our friends in industry and in the educational field enthusiastically came to our assistance with suggestions and plans, and there remained to be worked out only the mechanics and similar details of the course design.

IN designing a particular course it was believed desirable that the consensus of the best thinking and planning of three types of qualified men be utilized: (1) the manufacturer of the equipment to be studied and taught who normally would have all the information regarding the operation and maintenance of his equipment; (2) the field officer who is going to employ the skills of the graduate students and who, therefore, knows the minimum qualifications required; (3) the instructor who is to be the intermediary in transmitting to the student the information which the manufacturer has and in imparting the skills which the officer in the field requires.

ORDNANCE SOLDIERS OVERHAUL A 75-MM. TANK GUN

When such men met to design a course of instruction in a particular subject they had a definite objective: to establish a course of study which would train an individual to perform a specific task. In other words, it was somewhat like building a mold which, when filled with metal, would produce an object of definite size, shape, and form and meet certain very definite specifications.

Conferees, after meeting as a committee to plan and set up the over-all training objective and the type of instruction deemed necessary, then meet in smaller groups to prepare outlines of specific phases of the instruction, decide how much time should be devoted to each phase, survey the existing text references, visual aids, films, models, charts, etc., and decide whether new ones should be developed to facilitate the teaching of the course. The next step is to prepare manuals and guides for the instructor to follow in his day-to-day work, with job sheets, outlines, schedules, and other essential material.

Then the various phases must be coördinated into a unified program, and a school in which to make a "trial run" of the new course must be selected and equipped in order to test the efficiency and thoroughness of the planning work. Members of the design conference observe the "pilot course" during its test run, and incorporate any additions or changes which seem advisable. If the product of that pilot course meets specifications—that is, if the graduates are adequately trained to perform the duties which had been laid down as the objective of the course—then the Ordnance Department is ready to institute the course as standard for the production training of future students in that particular specialty.

We were reasonably certain that this approach to our problem would be effective, but many reports from the combat zones of the several theaters have brought final confirmation and approval. Under combat conditions, our trainees have been performing efficiently the jobs they were trained to do.

From the standpoint of the individual soldier, course design had solved our biggest problem. We now had courses of study, stripped to bare essentials, complete with instructor guides and adequate training aids, which our newly trained instructors could administer in the time allotted and which would develop the desired skills in our trainees. The only difficulty was that there were too few instructors. It was necessary, therefore, to institute a teacher-training program concurrently with the training of students. The Ordnance Officer Candidate School became a fertile field for instructor training. Young officers, who qualified as potential instructors from the standpoint of background, technical knowledge, and temperament, were assigned to schools where they could be given advanced work in training methods. A training-methods staff was organized, and a thorough, if somewhat brief, course instituted in the techniques of instructing.

DURING the early days of mobilization, the transition for some young officers from the status of student to instructor was rapid, to say the least, but no instructor went before a class without having been given an understanding of the desirable traits of an instructor, how to use the blackboard and other teaching aids, how to prepare lesson plans and job sheets, and how to employ questions and student participation wisely. With this training of instructors and with the printing of instructor guides based on the new streamlined courses, the challenge of that vastly increased number of students could be, and was, met.

Earlier there was cited as one of the initial handicaps of mobilization training the shortage of physical facilities—buildings and equipment. Speed in relieving this situation was essential. Fortunately, the Ordnance Department was able to turn to civilian schools for help—to schools operated by industry and to private and public academic institutions—and they responded to the appeal magnificently with splendid coöperation. There were, perforce, many expedients. The Military Training Division of the Ordnance Department even went so far as to turn abandoned CCC camps into training schools, particularly into automotive-maintenance schools. As temporary expedients they served a worth-while purpose, and an excellent job was done, just as the civilian schools made a valuable contribution in training Ordnance technicians.

But from the start there were certain readily discernible

deficiencies in the suddenly expanded training facilities. Trainees were being taken from civilian pursuits, indoctrinated with Army customs and procedures during a brief four weeks of basic training, then transferred to a civilian specialist school for technical instruction during which period much of the benefit of the basic training was lost. There were also the problems of overhead and equipment. Costs and instructional difficulties were multiplied many times by dispersing small groups of students in many schools. It was necessary to spread equipment thinly until adequate training aids could be developed. In many instances it was necessary at first to use obsolete equipment for practical instructional purposes.

Small, specialized schools also meant that courses of instruction in allied subjects could not be made available without the necessity of transferring students from one school to another at considerable expense and with material loss of critical time and coördination. Nor was the desired standardization of training possible when equipment and facilities varied to so great an extent. Uniformity of training, obviously so greatly to be desired, was most difficult under these conditions.

ORDNANCE TROOPS DISASSEMBLE A 155-MM. GUN

When the consolidation phase of our training was reached at the beginning of the calendar year 1943 and it was possible to function under somewhat less pressure, an opportunity was afforded for progressive reorganization. The concentration of specialized training in a few major establishments became feasible, with worth-while results from the viewpoint of both trainees and the Ordnance Department. Overhead costs were reduced, more efficient use of instructor personnel was developed, allied courses of instruction were instituted, and all students could have access to the latest equipment available.

The process of consolidation still continues. Gradually it has become possible to concentrate more and more of the most highly specialized training in one or two specially equipped establishments, with a resulting decrease in the number of civilian and manufacturers' schools which continue to train Ordnance technicians. The consolidations in no way detract from the vitally important and uniformly excellent job which the civilian schools contributed at a time when their assistance was so badly needed. But as greater facilities became available for training at existing military establishments, the advantages of carrying on instruction near allied Ordnance activities were too great to warrant continuation of most of the nonmilitary schools.

The training of the individual soldier, however, was only part of the job. It had been thought at first that technicians could be mass produced like separate parts on an assembly line, then put together to form a maintenance unit or an ammunition company. While that system will work, it was discovered that there was a better way—a way in which the high degree of unity and teamwork essential to such highly specialized Ordnance groups could be developed. That led to today's emphasis on unit training—the training of a unit from the very beginning.

UTILIZING a mobilization training program which specifies subject by subject, hour by hour, the training to be received by the individual soldier from the start of his first four weeks of basic military training through his technical training—a period recently increased from thirteen to seventeen weeks—it has been possible to establish suitable unit-training centers, specially staffed and equipped to do a job similar to that of our schools, to turn out as an end product trained Ordnance units that will meet certain definite predetermined specifications. Officers trained in advance as specialists and instructors and specially selected for their qualities of leadership now carry on the training of the unit from its inception so that officers and men live and work together as a smooth-functioning team.

It was in unit training that the full benefit of our emphasis on practical work has been felt. Some of the first reports from the combat zones stressed, among other things, the importance of a thorough grounding in military fundamentals for individuals, intensive cultivation of the spirit of teamwork on the part of members of the organization, and practical experience so complete and detailed that the men will not be surprised or dismayed by any conditions with which they are faced upon entering the combat zone.

Those factors became the guiding principles in unit training. Infiltration courses, combat villages, and booby-trap instruction were only a part of a unit's training. The following experience of one Ordnance unit in the field on a week's problem may be taken as typical of our unit training today:

Moving into its bivouac area by truck, the unit was ambushed and its officers "killed." Noncommissioned officers assumed command and directed the defense until officer replacements were sent from headquarters. During the afternoon, scouts brought word that a gun of unstated size was "out of action." After reconnaissance by noncommissioned officers, a recovery crew departed and located the gun badly mired in a ditch. After hours of back-breaking work, the gun was retrieved and put back into action.

Toward evening, word was received that a half-track had been overturned approximately fourteen miles distant; another crew was dispatched, finding the vehicle on its side in a deep ravine. The ignition was missing, the battery was gone, and the gasoline and oil had been drained. Using only a 2½-ton truck with winch, the crew maneuvered under blackout conditions until the vehicle was righted, put in running condition, and brought back to the base under its own power six hours later.

Sometime after midnight, word came that a tank was disabled in an area fifteen miles away. A crew plunged into the

pitch-black forest and made its way through dense underbrush and ankle-deep mud to reach the disabled tank. With the aid of a wrecker it was brought back to the base five hours later. The next night, during an 8-mile march, the unit was again ambushed and temporarily stranded when a bridge was blown up in its path. A patrol suffered "casualties" in an attempt to clear a by-pass before the unit finally fought its way through to its destination. For two days, members of the unit did guard duty and 18-hour tours of work duty at a base shop which had been set up in the area. Before the week was completed the men had worked and lived through hours of continuous rain which all but washed away their tents and equipment.

Innumerable other instances could be cited of similar training experiences which Ordnance units have undergone—pitched battles, aërial attacks, strafing, mechanized attacks, blackout conditions—all to the end that when finally assigned to duty in combat theaters, Ordnance soldier-technicians will be confident that they can perform their duties regardless of what conditions face them.

Units which have completed their seventeen weeks of training fortunately do not always move immediately to overseas assignments. To utilize to the fullest all available training time, a continuation of the training program becomes effective upon completion of the first seventeen weeks. This continuation program also normally covers a 17-week period, but inasmuch as a unit will frequently receive its overseas assignment before this second period has been completed, the program is so arranged that it may be suspended at any time without loss of continuity.

DEVELOPMENT of advanced technical skills and cross training is heavily emphasized in the continuation program. That does not mean that the subjects which comprise basic training are slighted. On the contrary, extensive field problems are devised to bring into action all phases of earlier training, both in the nature of a review and also as a basis for advanced work. As in the first seventeen weeks, functioning of the unit under strict combat conditions and as a team are considerations receiving equal attention with the development of advanced technical skills.

The fact that the technical phases of an Ordnance soldier's training seem to be stressed should not obscure the fact that all Ordnance training is pointed at developing first a soldier and secondly a technician. This conception of soldier functions is reflected in every program, whether it be at a unit-training center or at the replacement center.

The replacement-training-center program, also now lengthened from thirteen to seventeen weeks, exploits fully the advancements in training which have been noted in connection with school and unit programs. The replacement-training center benefits from the designed courses of instruction and from teacher-training programs, and, with its own infiltration and combat courses, booby-trap instruction, and anti-aircraft firing range, gives the trainee replacement the same combat experience which is received by the Ordnance soldier in unit training.

During our peak training period, the officer-candidate-school course was thirteen weeks in length and included both military and technical training. While excellent officers were graduated, it was felt that the time allotted was insufficient to produce trained technicians of the desired qualifications. Hence, recent authorization to extend the course to six months was most welcome. During the first four months, an officer candidate is schooled chiefly in strictly military subjects, including a month in bivouac in the field. At the end of the four months, successful candidates are commissioned as second lieutenants and then, as officers, enter the technical-specialization phase of their training which continues for approximately two months.

The lengthened period of time has made possible the incorporation in the officer-training program of much material which combat experience has proved desirable for the young officer and has provided more opportunity for him to exercise the responsibilities of command.

IF there is one outstanding factor in the training picture it is, perhaps, the highly fluid state of all Ordnance training at the present time. Once the initial expansion was over and the theory of the "end product" was firmly established, the way was open for rapid modifications to meet the ever-changing demands imposed upon training by conditions and developments in the theaters of operation.

There is not, nor has there been, a static quality in Ordnance training; on the contrary, it has been extremely sensitive to the needs of the line in the field, which is its ultimate mission of service. New doctrines and new techniques which have been proved in combat theaters are incorporated promptly into all courses of instruction and training programs. Our courses of today are quite likely not the courses we will be teaching tomorrow, but as of today they represent the latest thought and experience on a given subject.

What applied to instructional programs also applies to the establishments themselves. Schools, replacement-training center, unit-training centers, all are so organized that whatever the needs of combat—be they a new base group headquarters involving the training of senior field-grade officers or a new specialized task-force unit—the facilities exist for adequate, prompt, and efficient training of officers and men.

The Military Training Division of Ordnance is, indeed, comparable both to the mass-production factory and the craftsman's shop—it is equipped to turn out vast numbers of units composed of skilled technicians, and it is equally capable of turning out small, select groups or individuals with the highly specialized knowledge and technical skills to discharge a special mission.

Ordnance training has borrowed from traditional academic education, from industry, from the trade school; it has mixed salesmanship, showmanship, and psychology, and has adapted all to the pattern of the Army system. It is believed that Ordnance training has, on the basis of many reports from combat zones, fitted Ordnance soldier-technicians to accomplish their mission as "servants of the line," and that is the conclusion on which the Military Training Division focuses its vigilance. We are never complacent or satisfied with our results but are keenly alive to the necessity for keeping abreast of the latest developments and incorporating into our curriculum the best doctrine and the finest teaching methods adapted to our needs.

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EDITOR'S NOTE.—For further information on Ordnance training, readers are referred to "Classifying the Ordnance Soldier," by Capt. Robert C. McQuiston in the July-August 1943 issue of ARMY ORDNANCE (Vol. XXV, No. 139, p. 100); to "Ordnance Personnel Procurement," by Capt. Bernard B. Abrams on p. 525 of the May-June 1943 issue; and to "Training the Ordnance Soldier" by Brig. Gen. Julian S. Hatcher on p. 272 of the September-October 1942 issue.

# Production for Victory

## Industry and Ordnance Were Prepared for the Present Conflict

Brig. Gen. J. S. Hatcher

THE slogan, "Ordnance Is Big Business in Action," is really an understatement—Ordnance today is the biggest business in the world. Let us go back to 1916. In that year the entire United States Government, including the Army and Navy, the Post Office Department, the Departments of Interior and Agriculture, and all the other Government offices and businesses, cost about one billion dollars. But during the year and a half of war which followed, the Ordnance program cost three and a half billions—over three times the cost of the entire Government of the preceding year.

That is surely an example of big business in action; but even that colossal performance pales into insignificance beside the fact that in the present war the Ordnance Department has received something in the order of fifty billions of dollars! Approximately sixty-two per cent of all Army Service Forces' expenditures are made by Ordnance, while all the other departments, such as Quartermaster, Medical, Chemical, Signal, Engineers, etc., account for the remaining thirty-eight per cent.

There are many contrasts between this war and the last, and one of the most startling is the difference in the armament of our allies. In the last war, our weapons, tanks, and planes started to be produced in volume just as the Armistice was signed. As a result, we fought that war with weapons, tanks, and planes furnished by our allies—the French 75, the British Vickers and French Hotchkiss machine guns, the Renault tank, the Schneider howitzer, the G.P.F. 155-mm. gun. In this war, the picture is reversed. Our allies are fighting with weapons, tanks, and planes furnished by United States Army Ordnance.

One of the principal reasons for the contrast is the success of the Ordnance district system. In the last war, when we found a need for production of a tank, for example, the first thing was to find out the likely producers, the manufacturers who had plant facilities and experience which fitted them for the job. When this was accomplished (and it might take from one to six months), the next thing was to acquaint the maker with the character of the job and to make factory plans for doing it in his plant—often to make changes in design to accommodate the machines and methods available. It took fast work indeed to locate the facility and get it really started on the job in less than nine months. When we consider that our very small peacetime Ordnance Department had to be expanded to take care of hundreds and even thousands of such production orders, we can visualize the hopelessness of the task we faced.

Our Ordnance officers, both Regular and Reserve, are not only smart businessmen; they are realists of the highest order. They were sure that the Nation, which had just won at tremendous cost the War To End All Wars, was in no temper to maintain a huge reserve of munitions and weapons against the possibility of another world cataclysm. They were equally sure that to fail to make some adequate provision against the possibility of such a conflict would be suicidal. Even if appropriations could have been obtained for constant maintenance of a large armament, there still remained the problem of obsolescence of design and provision for rapid production of the new and improved weapons which are always developed during the years of a war.

The solution of the problem thus posed was found in the Ordnance district system. During the past twenty years of peace, the far-sighted and patriotic manufacturers of this Nation have coöperated with the many Reserve officers and the few Regular officers of our thirteen Ordnance districts to find what would be needed and where it could be made, to tell each manufacturer what he would be expected to do, to acquaint him with designs, to modify designs where necessary to fit existing machines and methods, and to make detailed factory plans for such production as could be foreseen.

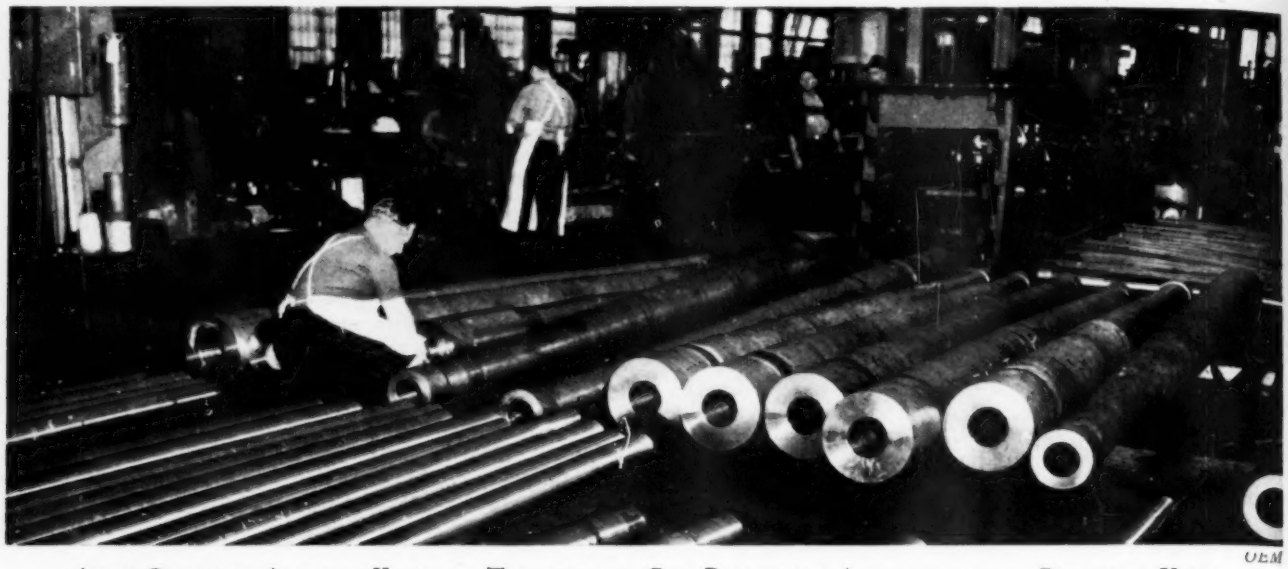
The Ordnance Department and the Nation owe a debt of gratitude to the Reserve officers who kept the faith through all those years of peace; who willingly gave their leisure to the study of Ordnance problems; who spent their vacations on active duty in the district offices; and to those realistic, farsighted manufacturers who gave money, time, and effort to factory planning for war production with no hope of any reward except the satisfaction of a real duty modestly, but ably, performed.

ANOTHER reason for the phenomenal success of the Ordnance production program is to be found in the system of Government-owned, contractor-operated Ordnance plants established by the present Chief of Ordnance at the beginning of the emergency. He had vision enough to see that a production program of such size was far beyond the management capabilities of any group in the Army or anywhere else in the Government; that the only way it could be accomplished was by enlisting that great mass of managerial talent that the long years of peacetime competition in industry had brought to the top of the heap. He therefore created a vast system of huge munitions plants built and owned by the Government, after which he contracted with the most outstandingly successful business firms in the country to operate and manage these plants. The result is that miracle of production which has enabled our Ordnance Department to arm all the nations who today are aligned against aggression.

Among the weapons now being produced in unheard-of volume are many which have been the subject of the most flattering reports from the various battlefields and fronts. The campaign of Guadalcanal dispelled any lingering doubts among those simple-minded souls who had allowed themselves to be deluded into the belief that the Garand rifle was adopted without the most exhaustive tests, both by the Ordnance Department and by all the using services, including the Navy, Marine Corps, and Coast Guard. One young Marine major who had been quite outspoken against the Garand wrote in to admit that he had been mistaken and to

General Hatcher is chief of the Field Service Division of the Ordnance Department.

This is an address delivered before the Rochester Post of the Army Ordnance Association, Rochester, N. Y.



OEM

Army Ordnance Arsenals Kept the Technique of Gun Production Alive during the Peacetime Years

say that after using the Garand in actual battle he was most thankful that his own advice against its adoption had been disregarded.

The multiple-gun motor carriage, M15, terror of the dive bomber, earned its laurels and made its reputation during the first landings in Africa, where one of these weapons shot down several dive bombers while it was still on the deck of the landing craft on its way to the shore.

The 105-mm. howitzer, mounted as a tank destroyer on the motor carriage, M7, known as "The Priest," had a brilliant share in the success of El Alamein. It is reported that this howitzer has destroyed German tanks at a distance of 10,000 yards.

The improved 155-mm. gun, known affectionately as "Long Tom," showed its worth in the Tunisian campaign by interdicting crossroads, harassing supply routes, and in one case by neutralizing an enemy airfield ten miles away.

THE 90-mm. gun with its highly effective system of fire control has knocked down enemy planes at 27,000 feet, and it is reported that in the South Pacific this gun brought down one enemy plane for each 50 shots fired as against the World War antiaircraft artillery record of something like 19,000 shots per plane.

The medium tank, M4, was the subject of the sincerest tribute that can be received by any weapon; namely, an appraisal by the Germans in one of their own intelligence summaries captured by our troops which describes the American M4 as the best tank on any battlefield.

Even nonshooting ordnance came in for its share of praise. A report from the Southwest Pacific states: "The ¼-ton, 4x4 truck (jeep) was really the answer to all problems. Never in our lives have we ever heard a vehicle more blessed than this one. Where other vehicles bogged down, the jeep came through. It is an indispensable piece of equipment."

Maj. Gen. J. P. Lucas, reporting on the Sicilian campaign, said: "The 2½-ton truck is the outstanding cargo vehicle in the Army, and without it this rapid campaign would have bogged down before completion because of lack of supplies. I have seen nothing belonging to our enemies or our allies that can compare with it."

While we of the Industry-Ordnance team may be pardoned for a feeling of pride in this production accomplishment, we must remember at the same time that it requires something more than production alone to insure success of the Ordnance effort. A tank produced and standing in a field in Detroit is of no use to the soldier in Italy. The bomb which is completed and stands on a siding somewhere in the Middle West is of no help to our Air Forces in China. The Army expects the Ordnance Department not only to produce weapons and ammunition but to deliver them to the troops all over the world, wherever they are needed, whenever they are needed, and in the quantities needed. And the troops look to the Ordnance Department to keep the most intricate and complicated instruments in repair and adjustment at all times, maintaining them not only against the ordinary operational wear and tear but also against the far worse damage resulting from destruction by shellfire, bombardment, and other enemy action.

This supply-and-maintenance function of the Ordnance Department is carried out by that division of Ordnance known as Field Service. In order to receive, store, issue, and maintain some billions of dollars worth of ordnance every year, Field Service has established the largest storage and distribution organization the world has ever seen. Ordnance comprises everything that shoots—from the smallest pistol to the huge 16-inch gun; every bit of ammunition that is shot from guns or dropped from planes—from the tiny caliber .22 cartridge to the gigantic blockbuster; everything that rolls—from the bicycle and the jeep to the 10-ton wrecker and the 60-ton tank. There are some 2,200 separate major items of ordnance, with nearly 400,000 different kinds of spare parts needed to keep them all in repair. The job of storing all this and knowing where each item is and of being ready to furnish parts to some 50-odd different theaters of operation in all parts of the world is one to stagger the imagination.

Consider a single day's business of one of our depots shipping supplies overseas. Most of the items on the thousands of requisitions received that day were promptly started to the port, but a certain percentage had to be ordered in from other depots by teletype. For this one day's business, the left-over items that had to be brought in from other depots filled a closely written teletype blank 160 feet long!

*Signal Corps*

CALIBER .50 MACHINE GUNS ARE PRODUCED IN QUANTITY IN CONTRACTOR-OPERATED PLANTS

Ordnance Field Service stores not only all the material made for our own armies but that for Lend-Lease war aid as well, in addition to certain materials for the Navy and the Marines. For these purposes, Field Service has more warehouse storage space than is contained in all the civilian warehouses in the country combined. There are over forty large Ordnance depots in the continental United States, many of which store ammunition as well as general supplies. The aggregate value of the materials handled in and out of these depots is several hundred million dollars a week.

WHERE ammunition is involved, the greatest precautions against accident are observed. The storage places are far enough removed from large centers of population so that no great loss of life or property would occur in case of accident. Storage is generally in underground magazines which are safe from fire, lightning, bombing, or shock of any near-by explosion. Quantities in each magazine are small and distances between magazines are selected so as to make it impossible for the explosion of one to be transmitted to the next. In the many thousands of such magazines in daily use, there has been only one explosion since the war started. In this one case, the magazine was destroyed and the several men working in it were killed; but no damage was done to the ammunition in any of the adjoining magazines and no injury to personnel elsewhere in the depot. With the precautions that are observed, this is about the worst that is to be expected in the way of an accident in such a magazine area.

The typical Ordnance depot will cover perhaps 25 square miles of land; will have 1,000 or more magazines connected by some 200 miles of hard-surfaced road and some 50 miles of railroad track; will have its own locomotives and rolling stock; will contain some two or three million square feet of storage space, stocking some hundred thousand separate items of ordnance; and will have maintenance shops for factory overhaul of damaged items sent in from the field. There is nothing like this in industry—these large Ordnance depots dwarf the largest storage operations of our great corporations.

Encouraged by the brilliant success of the Government-owned, contractor-operated munitions plants, the Ordnance Department has recently arranged to have several of the Ordnance depots operated by outstanding industrial firms under a similar contract arrangement. Col. Robert R. McCormick, writing in the Chicago *Tribune,* made the following editorial comment on this development:

> "This move demonstrates the good sense which appears to rule the Army Ordnance branch. The soldier's job is to fight. It is also his job to decide what weapons he will use and to supervise delivery of those weapons to the places they are needed. But the civilian manufacturer, warehouseman, and transportation man, once he is told what is wanted, can do a far better job of making those weapons, storing, shipping, and routing them than the soldier can. The Ordnance Department recognizes this."

While Ordnance supply and maintenance in the continental United States are handled through Ordnance Department or service-command depots and supply points, abroad in the actual theaters of operation they are handled by Ordnance Field Service troops. Every division, corps, and army has its own Ordnance company, battalion, and regiments or groups. There are maintenance companies of various kinds, equipped with mobile shops and tools to perform actual battlefield recovery and repair, often under fire. There are depot companies which run the supply points and ammunition companies which run the dumps. From five to eight per cent of our soldiers in the field are Ordnance men, and some of the jobs they perform are among the most arduous, dangerous, and nerve-racking, such as, for example, the neutralization of mines, booby traps, and time bombs—with their lives as the forfeit in case of failure.

Few people realize the accomplishments of these soldiers and the dangers they face. For example, in the campaign of Bataan Peninsula where some five per cent of the soldiers were Ordnance men, these same five per cent received fifteen per cent of all the Purple Heart decorations given for wounds in action. The public is prone to consider that any soldier who is in the Ordnance Department has found a retreat from dangers of the battlefield and is performing some safe job in a plant back home. The contrary is true. Ordnance soldiers are never employed in manufacturing plants, where all the work is done by civilians, but they are to be found on every battlefield performing some of the most dangerous tasks required in modern warfare.

# Overseas Repair of Military Tires

## Ordnance Shops Recondition Rubber for All Branches

Lieut. Col. C. W. Vogt

WHILE global strategy is bringing together the chiefs of the United Nations of the world, a detail of global tactics has been bringing together periodically a larger group of "smaller" men to plot the repair of the tires on which high strategy ultimately rests. One situation dictates both levels of planning: a compelling unity of purpose and the need of subordinating diverse means to the common end. The informal, voluntary, and highly successful Tire Repair Allocation Board, which has largely served as one means of conserving rubber, might not have been possible under other circumstances.

The Ordnance Department, as user of eighty-five to ninety per cent of the Army's rubber, was an instigator of the work of this board, where, under the sponsorship of the rubber branch, Production Division, Army Service Forces, all Government agencies interested in the critical problem of tire repair can thrash out their difficulties together. Without power to make binding decisions, this board nevertheless has prevented waste and dissipation of invaluable resources by actions taken as a result of concerted agreement of the board members.

Sc small a detail of international effort was raised to critical importance on December 7, 1941. Rubber supplies for America and Europe were on the burning Pacific docks that day. Rubber was in the holds of ships which never brought their loads home. And rubber was, of course, a principal ingredient of mechanical civilization whether in peace or war. The progressive motorization of the world might be measured by rubber production. World production in 1910 was 94,000 long tons; in 1920, 341,000 long tons; in 1930, 821,000 long tons, and in 1940, the year before rubber was cut off at its source, production was 1,390,000 long tons —an increase of about 1,500 per cent in 30 years.

This production was localized. Where in 1906 the Amazon Valley accounted for more than half the world supply of rubber and Africa for a third, in 1940 each of these areas was producing only about one per cent of the larger quantities and about half the actual tonnage they had once supplied. But the Far East, limping into the records in 1906 with 3 per cent of world production, increased its tonnage nearly 900 times by 1940 to fill about 98 per cent of the world's needs. This was the area and the traffic that lay under attack that day the Japanese chose to take us on. From that moment, our source of rubber had to consist of only our stock piles, our economies, and our ingenuity.

On that same day, as it happened, an engineer of one of the rubber companies was at home—it was Sunday—working on plans requested by the War Department and developed in conversations with the Quartermaster Corps (then responsible for transport vehicles) for mobile shops in which to repair and rebuild tires. For if rubber conservation had not then appeared to be a matter of life and death, it was certainly one of dollars and cents. Repair of its own tires by the Army was furthermore an element of advance planning, because units often need to be made self-dependent.

The greatest use of rubber by the Army is in tires for its vehicles. One division uses thousands of general-purpose trucks, each of which has four to ten tires, an average of seven. These trucks are built for, and used for, cross-country and all-country travel, and wherever military necessity sends them, they go.

Recapping of tires is closer to the experience of civilian highway motorists, but recapping was virtually unpracticed before Pearl Harbor. By and large it was more economical to replace than to repair tires until sources of rubber were cut off. So the reconditioning of military tires had little precedent to go by. But when realization of the significance of the loss of the rubber islands gradually sank in, the dealers and the motorists of the country quickly learned the possibilities of stretching rubber in new ways. These were the months when a speedy nation learned to restrict speed to thirty-five miles an hour, and prodigals became skinflints with what rubber they had. Substitutes and new sources for rubber were sought. And the economic orphan—tire repair—blossomed as an heiress.

THE Army profited from this sudden development of major reclamation of tires, and the shops designed for the theaters of war adopted the methods of the rubber industry. In mid-1942, the Quartermaster Corps laid out a tire-repair shop in one of its depots which was designed to be carried in truck trailers. In September, the responsibility for all vehicles was placed on the Ordnance Department, and the great bulk of tire operations for the Army was consolidated in one place. At the same time, and even before Pearl Harbor, similar tire-repair shops were being procured by several agencies for countries already at war.

In the meantime, the Ordnance Department initiated the assembly of shop equipment and the training of operating troops. But tire repair, of course, comes after tire use in point of time and after primary equipment in point of urgency. The overseas commands usually preferred to exchange tires instead of repairing damages and sometimes had to be encouraged to accept these services. The Ordnance program for tire repair was devoted to making shops ready when they should be required.

Mobile repair shops for tires, unlike those for other Ordnance repair in intermediate echelons, were abandoned in favor of stationary facilities, since the necessary equipment bulked so large, although at present mobile tire repair short of major rebuilding is under consideration. Large stationary shops, then, for servicing large numbers of vehicles in an area were designed and assembled. The difficulties of drawing together all the elements of trained personnel, sufficient and proper machine equipment, and suitable repair materials were so great that in April 1943 a Coördinator of Overseas Tire Reconditioning was appointed by the Chief of Ordnance as the representative of the chiefs of the Ordnance Field Service, Industrial Service, and Military Training Divisions.

Colonel Vogt is Coördinator for Overseas Tire Reconditioning, Office of the Chief of Ordnance, and chief of the Overseas Contract Section, Ordnance Field Service Division.

By that time, the formerly scattered responsibility for supply and repair of tires by the different services had been brought together in Ordnance, which was charged with overseas repair of all tires except Army airplane tires, as it still is today. Thirty sets of Quartermaster motor-transport tire-repair equipment had been taken over by Ordnance, and five tire-repair schools were established. Some shops originally destined for China were still in storage, and the task of getting into actual work in the theaters of operations was still largely ahead.

One of the early actions of the Office of Coördinator of Overseas Tire Reconditioning was the establishment of levels of tire supply for overseas theaters, since this was closely related to the question of theater repair. As an Adjutant General's memorandum of July 15, 1943, this basis of supply was established for all oversea departments, theaters, and base commands for the purpose of maintaining stocks of replacement tires and tubes at minimum necessary levels out of the available stock piles of rubber and manufacturing facilities. Automatic supply was ordered to cease, and requisitioning was removed from the bases of maintenance sets, lot sets, maintenance factor, or overhaul or distribution factor. Instead, a "daily replacement factor" was established as a basis for reserves, a given number of tires per hundred in actual use by kind being allowed for replacement, and stocks being limited to the theater's authorized days of supply multiplied by this factor. One tube was authorized for each two tires.

IN September, through another Adjutant General memorandum there were established the procedures of reconditioning and movement of unserviceable tires to and from overseas repair shops. Most significant was the clause reading: "Each tire-repair plant furnished to a theater of operations will service to the fullest extent of its facilities and capacity all sizes of tires, tubes, and flaps for Army and Navy equipment except airplane tires, tubes, and flaps . . ." This authorization of Ordnance shops as service agencies for all arms overseas itself eliminated what might have become a drain on the limited resources for such repair available to the Nation.

In May 1943, Ordnance was charged with developing an adequate plan of operations and necessary directives for proper utilization of tire-repair facilities serving the Alcan Highway. Accordingly, two representatives of the office of the coördinator visited this area. Because responsibility for this tire repair had been divided five ways, much surplus equipment and repair materials had been procured. The Ordnance officers brought these facilities into a unified plan and sent some of the surplus back to the United States. In place of five sources of rubber-repair materials, they established a single source, with a consequent saving of the materials formerly dissipated in the pipelines of supply. Tire-repair shops were established and put into operation at Fairbanks, Whitehorse, Dawson Creek, and Edmonton. As a result of this visit, $54,000 worth of unused equipment was set up in two shops and $45,000 worth returned or requisitions canceled.

The responsibility of the coördinator lay largely in putting shops into effective operation overseas—a matter of matching men and equipment and materials at the right time in one place to receive the directed flow of tires from all arms. The story of one shop established on a Pacific island serves to illustrate the task. Training of men for this and similar shops was under the Ordnance Military Training Division in the five schools and, in some cases, at rubber manufacturers' plants. The tire course was of two months' duration for the men and twice that for officers. A company for operating one shop consists of about 140 men and 4 officers.

The shops were completed in all details before being boxed for shipment: pipes were cut to fit, and ready-made valves and fittings, electrical wiring, and every other preparation assured the shop self-sufficiency and permitted assembly and operation under any conditions. The shop carries its own utilities—generators, boilers, and so forth—as well as equipment for repair of all sizes and types of tires used on general-purpose and combat vehicles by the U. S. Army, Navy, and Marines. The shops were furthermore divided into two parts, complete in every detail on half scale, so that they could be split into two units for added security against bombing or so that in advances one part could leapfrog ahead while the other continued in operation. A shop costs from $125,000 to $150,000, is set up for operation in 2 buildings, each approximately 30 by 100 feet, is shipped in about 10 carloads, and carries a third of a million pounds of rubber and patch material for 3 months' operation.

The shop and company which went to a Pacific island had to remain on board ship for several days while a suitable location was found. But eleven days after ground was broken the company had erected its own building, under the supervision of an Engineer officer, and four days later had recapped its first tire. The commanding general of the Services of Supply for the area welcomed the new service as a means of conserving ship space, both in- and outbound, and as a means of conserving rubber. "Not only will it materially reduce the number of tires essential to this theater that must be shipped from the United States," he said, "but it will practically eliminate the necessity of shipping tires back to the mainland to be repaired."

This Pacific-island company, in a month and a half, operating 24 hours a day, turned out 7,620 tires and 2,167 tubes after having made 15,887 units of repair. This rate of operation revealed that the generators provided with the set could not stand the pace, but otherwise the equipment was satisfactory. Even some rubber landing boats were repaired by the shop, as well as bullet-resisting tubes for the Marines. The company reports having removed 600 tires from vehicles in one week to make necessary repairs, thereby preventing the more serious defects that would have resulted if the tires had continued in use unrepaired.

The established method of receipt, storage, and issue of tires and their component parts is through the base depots to which the tire-repair companies are attached, except that unserviceable tires are turned in whenever possible direct to the shop, which issues a credit memorandum. Repaired and recapped tires are considered the equivalent of new tires, and requisitions or exchange for ground tires are filled when possible first by reconditioned items in preference to new items. Doubling the life of a tire requires for recapping only about a quarter of the rubber in a new tire. Tires and tubes that cannot be repaired are salvaged and shipped to the United States. Synthetic rubbers being used by the Army are found to be equally repairable, although the method in some instances is somewhat different from that used with natural rubber. These tire-repair bases are assigned upon request of theater commanders on the basis of the number of tire-using vehicles in the area.

After a start had been made by the Ordnance Coördinator of Overseas Tire Reconditioning toward readier matching of trained men to sufficient and proper equipment

and repair materials, it was realized that the coördination demanded by the critical nature of the rubber shortage had to be wider than that in the Ordnance Department alone. The advisability of tire reconditioning overseas had been proved and the project had been removed from the questionable class. There was not enough of this equipment or materials to go around, but it was found that some shops were available for reallocation due to changes in the military situation and, furthermore, that certain requests from foreign countries might be more judiciously met other ways than by new production. Accordingly, on May 4, 1943, the coördinator recommended to the chief of the rubber branch, Army Service Forces, and to the Office of Lend-Lease Administration, that all interested agencies voluntarily form themselves into a board for the allocation of tire-reconditioning equipment.

This suggestion was accepted, and an informal group known as the Tire Repair Allocation Board was formed with representatives from the Army Service Forces, Army Air Forces, Ordnance Department, Navy Department, Marine Corps, Office of Lend-Lease Administrator, Treasury Department, and War Production Board. The stated purpose was to clear all requisitions for equipment, tools, and supplies to be used for reconditioning tires in all parts of the world.

When this board first met, the most notable break with tradition was in the fact that a group of men with important responsibilities in unrelated agencies of the Government and some with responsibility toward foreign governments had decided to handle a critical situation without the force of authority but on the basis of mutual and, among them, complete understanding of the problem and with reasonable understanding of each other's problems. In a few months this board was able to settle and turn into a matter of routine, problems that had in the past been considered most complicated.

SEVERAL instances of the work of the board may be given. The government of a small foreign nation had requested a number of tire-repair shops, but data available to combined military and civilian agencies represented on the board showed that such demands must include also an unjustified quantity for civilian tire repair. The request was withdrawn. Army representatives of another foreign government requested similar help. The problem was studied by officers of the United States Army who had had experience with this type of repair, and it was shown to the foreign government that existing facilities in that country might be employed for the base work required by their army. Methods and procedures were proposed. The advice proved to be entirely acceptable, while the supply of this type of equipment was conserved.

It was found and agreed on by the board that some equipment being requested could not be justified on the basis of known requirements and that justified requirements need not be newly manufactured since some surplus and excess stocks or stocks procured for points now closed to allied shipping were available. Accordingly, the board accumulated information relative to tire-repair equipment and materials known to be on hand in commercial or military use in each theater or foreign country. It determined the quantities of tires by sizes in each theater and country. It established bases for issue of both tire-repair equipment and tire-repair materials. The board then set itself to supply equipment and material so determined from "surplus" or from equipment on order for low-priority uses. Projects that would have meant duplication by the Army and Navy were combined instead.

In the course of a few months, a million and a quarter dollars' worth of unused equipment was channelized into use and earmarked or in operation. The board dealt with over three million dollars' worth of tire-repair equipment altogether, not including prior procurement already in use by the Navy, Army Air Forces, Marines, and Lend-Lease.

Cancellation—and agreeable cancellation—of pending requisitions for tire-repair equipment amounting to over half a million dollars was brought about by board action, and equipment was salvaged from warehouses to the amount of nearly another quarter of a million dollars. These actions were important in relieving the pressure on industry and ultimately providing greater facilities for the civilian needs of American tire users. Since much of the repair material is perishable, the stock pile of rubber was further conserved by routing out from warehouses all unused stores.

ONCE this over-all global plan, aimed at preventing geographical duplication of tire-repair facilities, was initiated, it was agreed that all requests for Lend-Lease equipment passing through the allocation board would be required to show on the original requisition the data necessary for determination of needs: the available repair equipment, the quantities and sizes of tires in the area, and the quantities of materials available. By this means the world facilities are tightened up and control is exercised to see that all facilities in all countries are enlisted.

In the early days after Pearl Harbor, quantities of tire-repair equipment had been procured in a rush, sometimes before determining needs, techniques, and availability of personnel. The result was a drain on critical materials and an accumulation of stock piles of unused tire-repair equipment and rubber. Actual requirements were difficult to judge on a world scale. Military fortune had laid similar problems at the door of the Ordnance Department, and both situations had elements of confusion which defied the usual channels. Where Ordnance coördination required the bringing together effectively of all the elements of successful tire repair in the theaters of operations, the work of the allocations board was rather the disposition in a judicious manner of all the resources of the friendly nations.

A by-product of the accomplishments of the Tire Repair Allocations Board is the discovery that a most complicated and seemingly unsolvable problem involving many agencies can be turned into a comparatively simple routine by means of mutual understanding and common purpose.

The present program in the Ordnance Department looks toward increased maintenance and preventive maintenance in the lower echelons. It is believed in Ordnance that tire repair and recapping as practiced in the shops (now increasingly available in different theaters), combined with vigilance on the part of the using troops to catch tire injuries in early stages, can easily double the life of the average Army tire and in effect stretch still further the rubber stock pile of the Nation.

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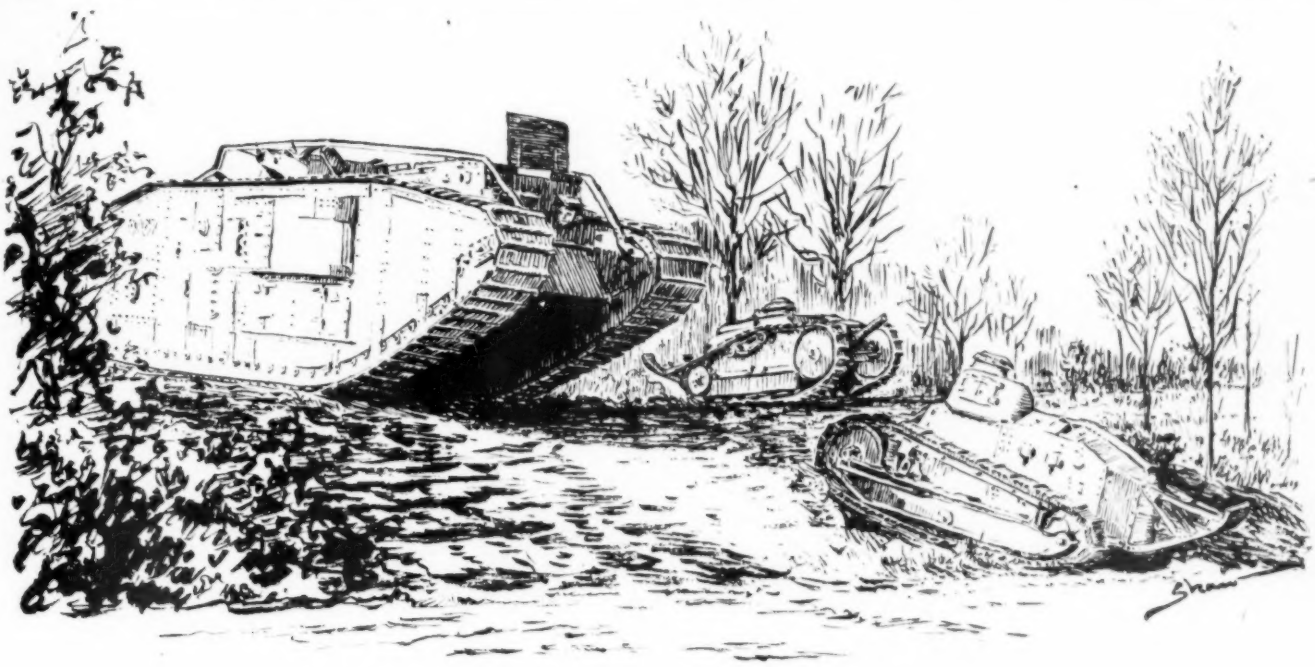
EDITOR'S NOTE.—Capt. B. W. Wood, writing on the conservation of Army tires in the May-June 1943 issue of ARMY ORDNANCE (Vol. XXIV, No. 138, p. 547) states: "In studying the causes of tire failure, underinflation has been determined by the Army as the major avoidable abuse in causing tire failures. What causes underinflation?—carelessness. . ."



# After the Tank, What?

## The Armored Vehicle May Have Reached Its Limit of Development

Col. H. W. Miller

RECENT Russian reports say that in the first two weeks of the German offensive which began on June 26, 1943, some 3,000 of Germany's finest tanks, including their latest and largest tank of 62 tons, were destroyed. As a result, the German offensive was stopped and a Russian offensive was possible on July 12th. Three thousand tanks destroyed, one offensive broken, and a formidable counteroffensive begun in two weeks. So what about the tank?

The art of war has become so bewilderingly complex that its simplicity has been dangerously obscured. We are, therefore, apt to think in terms of a multiplicity of devices and gadgets rather than of the simple basic principles of warfare itself. It is probably true also that the rank and file of people have had little opportunity or occasion to distinguish between the art and the science of war, and therefore seldom think in terms of the specific purposes of the various devices, particularly when such devices become dangerously obsolete. We all seem to have a liking for what we call antiques. But in science, in industry, and in warfare we can indulge no such inclination—the cost is prohibitive.

Warfare is a process of subjecting one's enemy to one's will by violence, or the threat of it. The human being is ill designed for making war or for close conflict, but is magnificently equipped with a reasoning faculty that has enabled him to more than make up for his own physical inability to give and take punishment. There are only four principles or elements, or whatever one wishes to call them, involved in the science of warfare, and it is easily comprehended that they can never change.

Since the adversary in warfare is a human being ill designed to take punishment, men reasoned that the addition of some hard object to the hand—an object that would cut, pierce, or bruise—would make the hand more effective in harming an enemy. This is called "arming the hand." Men also comprehended that hand-to-hand combat was so dangerous that the slow, the dull-witted, and the inexpert had little chance. It was therefore very desirable to get at one's foe from as great a distance as possible. This led to "lengthening the arm" to many times its actual length. In this process, the invention of the simple bow and arrow was a very great one. It embodied much greater accuracy than the javelin, the throwing spear, or the sling, and its effective range of fifty yards and more served warriors for a hundred centuries.

The third principle or element of warfare which the human mind comprehended was the necessity of covering a very vulnerable body with some kind of protection—a shield, a barrier of stones or wood, or the shelter of a tree or trench.

THE fourth element or principle is psychological rather than material. It is the condition of disconcertion produced in one's adversary by surprise or speed of attack. Any creature will have, by intuition or by conscious thought processes, a plan of both attack and defense. If surprised or terrified, however, man seems to lose his capacity for quick coördination of efforts and may be unable to adopt the right plan of defense or attack in the short time allowed—thereby becoming increasingly vulnerable to the attack of the enemy.

To this date men have found just three methods of arming the hand to make it more effective than the fist. One is with some hard object of stone or metal capable of cutting or piercing or bruising. A second method comprises a mass of what we call high explosive, which carries with it destructive power many times that which can be generated by human

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energy. The third method comprises a mass of a corrosive chemical that may blind, burn, or nauseate one's enemy to the point of weakening his defense, if not of killing him.

For an uncertain number of centuries, perhaps for a thousand at least, the only methods of "lengthening the arm" involved the throwing process or the accumulation of energy from the labor of men in some mechanical device. These included the javelin, the spear, and the lance which, under Alexander the Great, attained the abnormal length of twenty feet in a device which was called the *sarissa*. In the hands of his heavy phalanx this exaggerated lance literally provided him with a mobile field fortification. The sling in which might be used a rounded stone or a mass of hardened clay the size of a baseball served as the equipment for the irregular infantry in early armies and forced the use of some protection for the head as well as for the body.

THE bow and arrow was a tremendous advance in lengthening the arm because it embodied the element of accuracy. Any device of warfare which cannot be made to attain a predictable degree of accuracy in offense and defense is of doubtful value and is likely to be discarded. The predictable degree of accuracy of the javelin and the sling was so low that they quickly gave way before the new invention, the bow and arrow. The bow and arrow has remained until modern times, and its accuracy still makes it of lively interest to sportsmen. The most revolutionary of modern methods of "lengthening the arm" was discovered in about the thirteenth century and involved the combination of sulphur, saltpeter, and charcoal in a tube that we now call a cannon.

The progress of the development of this new method of lengthening the arm was relatively rapid during the first two centuries after its discovery, but during the next four centuries its development was so slow that the cannon employing this suddenly released heat energy remained well-nigh the same until after the American Civil War. A new and increasingly dangerous form of this lengthening device, however, was so formidable at the time of the Revolutionary War that it may safely be said that it was the instrument that resulted in our victory in that conflict. This was the muzzle-loading flintlock rifle. Its accuracy at 200 yards in the hands of our backwoodsmen Colonial soldiers was such that nine out of every ten heavy lead slugs found their target in the body of a British soldier. This device was developed more rapidly in the following century than its ancestor the cannon so that at the very termination of the Civil War there was being introduced to the Northern Army a breech-loading rifle that would have wrought terrible execution had the war continued in 1865.

The cannon for field use was perfected in the French 75 and other similar devices to the point where it could be fired accurately at an unseen target at the rate of some twenty projectiles a minute. These projectiles contained many small bullets (shrapnel) for use against concentrations of infantry, or high explosive for the destruction of barriers and supplies, or corrosive gases for killing men or rendering them incapable of fighting.

The development of these devices to and through the first World War was so extraordinary that the French Army built cannon 21 inches in diameter firing projectiles weighing 3,000 pounds. The Germans built a cannon capable of firing a distance of eighty-one miles and used it to bombard the city of Paris. Sixteen-inch cannon had been installed in our seacoast fortifications and on battleships, and the projectiles from these were capable of piercing as much as sixteen inches of hard steel armor plate. By the end of that war it began to appear that the limit of the development of such arm-lengthening devices was already reached and that nothing more of this nature could be obtained.

Probably the earliest evidence of the recognition of the vulnerability of the human body to punishment by sharp instruments was the wearing of animal skins for the protection of the body against the claws of certain beasts. The more formal use of this protection, however, is found in the employment of round and long elliptical shields made of fire-hardened skins stretched on wooden frames. In the early Sumerian armies of 3000 B.C., many of these shields were the height of the men themselves. The early use of both the bow and arrow and the sling forced the protection of the head with a bull's-hide covering or helmet, and in succeeding centuries, as metal became available, these skin shields and helmets were replaced by metal ones more and more artistically shaped as war took on a more formal aspect. In the so-called Middle Ages, the original bull's-hide covering found its highest development in the ornate steel body armor of the heavily clad cavalrymen and heavily armored foot soldiers.

As unlimited quantities of metal have become available, there has been a well-nigh grotesque extension of the element of protection in armor as thick as 18 inches on the turrets and fighting tops of battleships, 16 inches of armor on the belts, and 8 inches on the decks. This armor serves its purpose or else it would not be used, for it constitutes an impressive percentage of the weight of the ship. The most formidable recent extension of this principle in another form was that of the Maginot Line. If this line had been finished and if it could have been served by men whose morale and supply systems were equal to the quality of their fortifications, the German armies might not have gotten through. Any instrument breaks down in the hands of a fighter of low morale or under a poor supply system.

THE science of psychology has been sufficiently developed now to enable us to see that there are certain highly standardized methods of producing disconcertion through surprise, speed of attack, and terror. We know approximately how the human mind and the emotions work and what the reactions are almost certain to be. Out of our meager understanding of abnormal psychology—because extreme disconcertion and terror probably belong in that field rather than in normal reactions—a certain group of plans or stratagems have been developed for warfare and are the favorites.

The staff of an attacking army knows that it must drive through to success before the enemy can reorganize his forces and defenses to meet this form of attack and thereby reduce the engagement to a siege or a stalemate. Almost every type of offensive involves the overwhelming use of power to destroy defenses, subdivide enemy forces, cut his lines of supply, and keep him disorganized until he is unable to resist further. When a plan of attack fails signally to accomplish these purposes, it is generally appreciated that the force applied was not sufficient, or that the enemy was informed in advance of the method to be used and was prepared to meet it, or that the devices designed to meet that form of attack have become such as to make the offensive prohibitively dangerous. If and when this happens, such a form of attack must be used most sparingly, else catastrophe will be the result.

It is probably to the point to make a philosophical observation to the effect that it may never be possible for human ingenuity to devise any methods of attack, defense, or concealment that cannot also be circumvented by human ingenuity if the inducement to apply that ingenuity is sufficient. It has been noted frequently that the greatest spurts of development of all kinds occur during time of war. It is at this time that the inducement for the application of every idea and device and for the use of funds for research and experimentation are greatest. It must be expected, therefore, that any new instrument of warfare which proves highly effective on its first few applications will induce the most intense countereffort of human ingenuity and will bring to bear the utmost of human bravery, endurance, and daring to circumvent and defeat that plan or device.

WORLD War I saw the first extensive use of the machine gun. It was evident within a very few months of the beginning of that war in August 1914 that human body protection was such that infantry could not advance in the face of automatic weapons. Without question, the machine gun held the center of the stage. Because of it, two long lines of soldiers dug themselves into trenches reaching from the North Sea to the Swiss Alps, and four years of the most peculiar and freakish warfare that we may ever know followed. Gradually, the larger form of the "arm-lengthening device"—the cannon—was greatly developed and used in well-nigh fantastic numbers. Cannon of all calibers were placed almost hub to hub along the entire line, and several lines were arranged in depth.

The combatant nations of World War I wished to increase the body armor of their soldiers so that they could resist the machine-gun and rifle bullets. It had long been recognized, however, that about the only protection that could be given the soldier in the field was a helmet and good shoes. Body armor of various kinds was experimented with during that World War and was used by certain groups of so-called "shock troops" and by groups of raiding soldiers who dashed back and forth across No Man's Land. Some of this armor was backed by sponge rubber to reduce the shock of bullet impact to the body, but the fact remained that there was no answer to the machine gun in anything that could be done to cover the individual soldier's body and still allow him the necessary mobility and freedom of action. Body protection for the foot soldier had reached its limit.

Precisely when or where or how the suggestion of the solution of this machine-gun problem was made, we do not know. It is said that a young British officer suggested it and that the idea reached Mr. Churchill, who promptly approved it. It was logical, of course, to look back and try to bring up to date the huge shields mounted on wheels used by Roman engineer troops. The Romans did not invent them, but those mobile shields were used extensively in storming field fortifications and walled cities.

There had been developed a few years before the first World War a type of power vehicle that could traverse open fields much better than a wheeled vehicle. This was known as the track-laying tractor and was used mainly on farms. It was suggested that one of these devices be armored sufficiently to protect it against machine-gun fire and that it be armed sufficiently with machine guns and eventually with small cannon to make it effective against strong points and machine-gun centers. In official correspondence in Britain, it was to be referred to by a term that would not identify it as a combat device. No word could be better chosen to conceal its qualities than the word "tank"—normally a container for liquids or powdered materials.

When these devices appeared for the first time in the hands of the British Army on the front north of the Somme River, they suggested nothing quite so much as modernized prehistoric animals. They were slow, lumbering devices with a shape never seen before. For a short time they were quite effective. The track itself, however, was poorly designed, and the engines used were unreliable. They were poorly protected for defense against weapons larger than machine guns, and their speed was not such as to embody the fourth element or principle of the science of warfare—disconcertion. They were simply slowly moving land fortifications, and, after the first shock of surprise, they met the fate that might have been expected.

By the end of the war in 1918, much development had been done in the design of tanks. It is still remembered that the use of some 450 tanks in a mass attack early in the morning of July 18, 1918, on the German line west of Soissons and north of Château-Thierry enabled the Allies to plunge through the front German line. But so slow was the movement of these tanks, and so vulnerable was their thin skin, that they were quickly halted and the effect of the break-through lost. Again, on August 8, 1918, the British and Australians staged an attack with some 400 tanks astride the Somme River, and broke through the German lines. They raced forward with their armored cars at such a rate that they surprised and captured divisional headquarters and staffs at their breakfast. But again so slow was the movement of the tanks and so vulnerable were they to field-gun fire that the effect of that break-through was also lost.

It is easy to see now why the mass use of tanks on the eighteenth of July and the eighth of August failed. They were sufficiently protected to be safe against the fire of machine guns, and they had sufficient firepower to operate against machine-gun emplacements, but they did not have sufficient speed to exploit the surprise nor had they sufficient protection to protect them against cannon fire. It was appreciated that they were and always would be both direct-fire and contact instruments whereas artillery in the main is an indirect-fire and noncontact instrument.

If, then, the tanks were to come under the direct fire of

accurately operated artillery they would be at a great disadvantage. They would require great maneuverability, high speed, and assistance from some other offensive arm. The only one that appeared at all possible and available was the newly developed *extension of the arm,* the airplane, which had 3-dimensional qualities, and used the most formidable of the *hand-arming* devices—high-explosive bombs, machine guns, and automatic cannon. Just how the operation of tanks and airplanes might be coördinated was not appreciated because there was very little time to develop these weapons.

THE first problem that the Ordnance Department found on its hands after 1918 was that of rendering the power vehicle of the caterpillar type vastly more reliable for field service than it had been in World War I. A check of the service of the track-laying tractor as a power device had revealed that there had been a major breakdown on an average of each forty miles. Millions of dollars were spent in developing the present-day power device that serves the road contractor, the builder of dams, the lumberman, the transportation services of the backwoods of Canada, and the farmer so admirably. These efficient machines are now taken for granted, and few realize that their qualities are the result of years of painstaking research on the part of the Ordnance Department of the U. S. Army.

At the same time that development continued on the production of a more reliable and more powerful track-laying vehicle, the Ordnance Department proceeded with the development of self-propelled artillery. This was, of course, merely such a modification of the tank that it became a piece of artillery. This was a necessity, if the tank was to retain its value in warfare. Therefore, long before it was appreciated how the use of tanks in large numbers might be employed in future plans of war to strike powerful blows wherever the line was the weakest and then to exploit that surprise to the maximum, our tractor companies were producing tractors and tank chassis of greater power, greater reliability, and greater speed on which the Ordnance Department mounted existing guns of from three to ten inches. It is a regrettable fact, however, that the Field Artillery itself appeared to have little appreciation of the future need for such devices, whether as tanks or as mobile artillery, and most of them went into our museums. But World War officers of the German general staff watched our developments and did appreciate their value in the study of the questions as to why they had lost that war. They were thoroughly determined not to lose the next one.

The French and the British were almost as stupid as we in not appreciating the developments necessary to suit World War I weapons to a future conflict. The French seem to have depended almost entirely upon the third element of the principles of warfare—protection—in the form of the fabulous Maginot Line. The chiefs of the French Army would not listen to the possibilities of tanks. Britain apparently was lulled asleep by the thought of security behind her ocean walls, and America apparently by a feeling of security in her isolation.

It remained for a very few men in the French, the British, and the American Armies to see, even so recently as 1938, the part the tank might play in the initial stages of an all-out war. It would be a device embodying all four of the principles of warfare—that of the armed hand, the lengthened arm, protection, and the disconcerting effect of speed of action, the equivalent of surprise. How long this combination would be effective and whether the vulnerable qualities of this device might be detected and exploited by those attacked to the destruction and neutralization of such devices there was no way of knowing. It was, of course, the expectation of Germany, which had developed vast numbers of specialized tanks and had planned their coördinated use with infantry, air power, and field artillery, that the fighting would be over before any of her victims could develop adequate protection.

No one will forget the manner in which the Polish Army was sliced to bits in September 1939 and the British and French Armies likewise cut to pieces in the spring of 1940. The mass use of high-speed tanks with the coördinated service of the airplane to clear out artillery operating by indirect fire proved devastating. Many of us who were watching the development of the war maps of France from day to day in the spring of 1940 prayed that the French Army might produce at least 500 powered vehicles, each with a 75-mm. rapid-firing gun, to meet those long spearheads of tanks, cut them off, and destroy them.

But the French had very few pieces of such artillery. The British and we had practically none. Furthermore, the tanks that were available were more than faulty and were not the essentially mobile pieces of artillery with the power needed to cut the German tank spearheads and destroy the tank units. It is said that General de Gaulle, in charge of a division of modern tanks, made excellent progress but, finding that he was not supported with supplies of gasoline and ammunition, finally had to cease his advance just when he was beginning to have some success. Here was a case of the effect of the failure of both morale and supply on what little protection the French had.

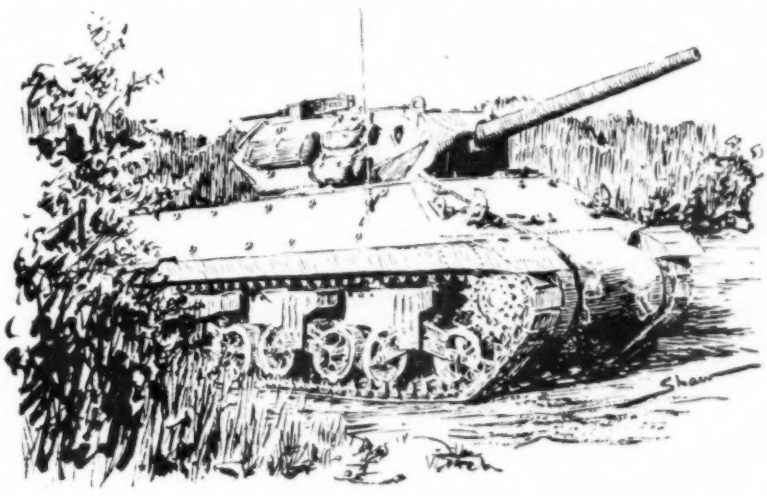
ONE can now look back to the spring and summer of 1940 and remember that the combinations of the masses of German high-speed tanks and the Stuka dive bomber gave us all the shivers. British and American Ordnance men worked like mad to try to retrieve lost time. We did not have the advantage of the long and laborious research and development that had gone on in the German Army. We produced the M3 (General Grant) tank of about thirty tons, with a short 75-mm. cannon in a sponson on the right side with only fifteen degrees traverse and a 37-mm. cannon in a turret on the top. As a power plant, it was beautifully designed; but as a piece of mobile artillery adequate for needs, it was mediocre.

Had the German Army been prepared to transport half a million men across the Channel and to put into Britain a thousand tanks, and all its air power in the summer of 1940, history would now present a far different picture. Germany was not so prepared, however, and although France was defeated primarily by its own defeatists, there was given to Britain, America, and Russia time to survey what the Germans had done in Poland and France and to plan accordingly.

It has long been appreciated by the strategists and tacticians of all armies, that little or nothing more can be done in protecting the foot soldier against machine-gun and rifle fire. He cannot be expected to clear out centers of resistance with his own rifle fire or hand grenades. He cannot adequately meet masses of artillery operating by indirect fire. Therefore, unless he were to be deprived of the device that had been developed to run interference for him, break down resistance, and exploit the element of surprise, the tank

would have to keep pace with all antitank devices. Because, to go back to our previous observation, the greatest amount of human ingenuity would be applied in trying to devise a defense against the tank.

In June 1941 the German Army pounced upon Russia. The Russian Army was sliced into bits, just as the Polish and the French and British Armies had been. The advance was terrifying, both in speed and in extent. The actual loss of the Russian armies in men and matériel and the loss to Russia of manufacturing centers and cities is probably beyond our comprehension. We may have to wait a long time for an accurate report. It was probably the superb morale of the Russian fighting for his home that retarded the advance of the German armies, however ably assisted by their tanks and planes, so that by Christmas 1941 the Germans had not been able to take Leningrad, Moscow, or Odessa.



During all this bitter summer and autumn, the Russians, fighting hand to hand, were learning how to destroy German tanks. They were learning that such close hand-to-hand fighting was effective. Bottles of gasoline thrown at the tanks, exploding when they struck, were very effective devices. The tank has almost no protection against fire, because vast quantities of air must be sucked into it for the crew and the engines; hence fire is a deadly weapon. The Russians were learning, likewise, that no tank can be fully protected on the front, sides, top, and rear. If adequately protected everywhere against artillery fire, the tank would be so heavy that it would be a useless device. Therefore, unlimited advantage cannot be taken of the third element of the science of warfare (protection) to save this device in order that it may run interference for the infantry.

Only somewhat over a year ago, we saw the German Army lure some 300 British tanks into a trap at Tobruk and destroy them with 88-mm. antiaircraft guns planted on the two sides of the trap. The Germans themselves were demonstrating that the war engine they had used with such devastating effect could be destroyed rather easily once within artillery range. Any army which has several hundred old antiaircraft guns of from three inches up, preferably mounted on self-propelled vehicles so that they may maneuver quickly, can probably destroy all the tanks that can be brought against them. We Americans hastily devised an antitank device by combining the M3 tank chassis and the 105-mm. howitzer with a certain amount of armor protection. Here was a self-propelled artillery piece simliar to those we had designed almost twenty years ago. It has proved very effective.

With this and the Mark 4 (General Sherman) tank, with a longer 3-inch gun in a turret with 360-degree traverse, General Montgomery was admirably fitted to meet all the tanks Marshal Rommel could send against him. Had it not been for the desert, which is an almost unconquerable thing, Montgomery probably would have rounded up all Rommel's forces long before he got back to Bengasi, and there would not have been any Tunisian campaign. It must not be thought that it was the fault of the antitank guns nor of the Mark 4 tanks that Montgomery did not completely destroy Rommel's army before it reached Tunisia. Rains and the desert probably made the German withdrawal possible.

It should be clear that we were witnessing alarming signs that the tank, which started as a puny weapon in the first World War and became such a powerfully destructive engine in the second, was beginning to show unmistakable signs of limits of development. There are many features of a tank which, if not capable of expansion, definitely limit the possibilities of that device. The capacity of the earth, particularly soft earth, to sustain weight per square foot of area, imposes very severe limitations on the total weight that any piece of equipment may attain, for a prohibitive area of caterpillar-type tracks may be required to give the flotation necessary for mobility.

The power that must be placed in a tank to produce the necessary speed cannot be expanded indefinitely. The armor that must be put on it to protect it adequately for its absolutely essential use has a limit. The firepower of its cannon and heavy machine guns is definitely limited. If and when the tank begins to reach its limit in these four categories—bearing pressure on the earth, power to drive it, armor to protect it, and firepower for destruction—one must then of necessity begin to think of other means of accomplishing the purpose for which this particular mechanism was designed. And the end or purpose of this contact artillery is to run interference for the infantry and, in high-speed warfare, to spread out after a break-through, cut lines of communication, and take the enemy in the rear so quickly as to produce disconcertion and confusion in large units, as we saw repeatedly in the campaigns in Poland, Belgium, and France, as well as in the Balkans and in Russia.

WE shall know eventually just how many tanks the Germans assembled in the region of Orel and Kursk for an attempted break-through in the direction of Moscow in June 1943. It is certain that they depended upon these tanks as in the previous two years' campaign to breach the Russian lines, cut their communications, and permit the armored cars and the infantry to get through. Neither they nor any one else has yet invented another method of accomplishing all this. A part of the assault may be accomplished by a devastating bombardment of the defenses to pulverize all means of resistance on a certain sector, but the breakthrough must then be accomplished by power vehicles carrying troops, firepower, and defense.

Inasmuch as initial surprise is the prime element in such an offensive, the forward movement of the great mass of tanks was not preceded by the formidable artillery bombardment that was the rule in the first World War. But the

Russian intelligence service was of such character as to obtain a fairly good picture of the German intention both as to the time and the exact place of the offensive. As a consequence, the Russians had taken every precaution possible to meet this tank assault. They had available bottles of gasoline with detonators, the newly developed American rocket gun, 37-mm. high-velocity antitank guns, and their own artillery of various calibers. The largest caliber used for antitank service was probably no greater than 105 mm. Practically all antitank work must be by direct fire, because the tank is a moving target. The only thing that can be accomplished with longer-range indirect-fire cannon is to tear up the roads and so slow up a tank assault that the smaller artillery can get at its targets more easily as the tanks move more slowly through the fields or over soft ground.

IT must be appreciated in considering the fate of the tank, that the Russians have chosen to use methods so heroic that many may question if those methods will be used by others. Under desperate circumstances, however, it must always be assumed that any group of men, particularly German troops against which we may find our own troops battling in France and in Germany itself before long, will employ the most heroic methods. By these we refer to the practice of lying in the fields or beside the roads as though dead and permitting tanks to come abreast, jumping to the feet and throwing bottles of gasoline against the sides of the tanks from distances no greater than thirty or forty feet. Likewise, in the recent German tank assault on the Russian lines, a Russian antitank-gun officer commanding 37-mm. gun batteries said that a very close study had been made of the largest German tank, the 62-ton "Tiger," to find its vulnerable points and that four had been found. One of them was near the fuel supply. He said he had placed his guns on the sides of the roads no farther than 200 feet from the road itself. At this distance, of course, 37-mm. projectiles can pierce a considerable thickness of armor, and if there are known vulnerable places in the tank, as there will always be, no tank could be expected to withstand this fire. He mentioned that he had destroyed fifteen tanks in one day with these 37-mm. guns at such close ranges and that seven of them had been the supertanks with which the Germans had hoped to pierce the Russian lines.

We may conclude then that the 3,000 German tanks destroyed by the Russians in a period of two weeks, thereby breaking the German offensive, were destroyed through the use of gasoline, rocket projectiles, close-range fire of 37-mm. guns, longer-range fire of their 50- and 75-mm. guns and 105-mm. howitzers. Probably the ranges were no greater than a few thousand yards at most and may have averaged less than a thousand yards. This emphasizes the close-combat character of the tank. If it cannot come to grips with the enemy infantry, it is a relatively useless device. And if the enemy is willing to use the heroic methods employed by the Russians, then the same slaughter may be expected on any battle front.

It is seldom in history that more convincing answers to certain academic arguments have been provided than have been furnished in this war. Historians, biologists, warriors have argued endlessly, but none has ever succeeded in convincing his colleagues that nations would proceed as brutally as have Germany and Japan. None could produce any convincing arguments as to the depravity to which men might sink in their mad lust to rule the world. This world war has produced such irrefutable answers that no one need discuss the question any more. In addition to this, we have had convincing demonstrations of the employment of the element of terror and the extent to which people can be subjugated by the process of terrorizing them. In the field of instruments also we have had such convincing demonstrations that again the academic arguments are swept aside.

WITHOUT question, wars will continue to the end of time for the simple reason that the human being is about the most unbalanced creature that has ever been on the earth. As we look forward to future wars we can see that the defenselessness of the human body will always make foot troops or infantry particularly vulnerable to the machine gun. We will not armor the man as we did centuries ago, because he cannot proceed with such a weight on him; his helmet and his shoes will continue to be his principal protection against certain punishment. We shall therefore need something to clear out the obstacles before him if he is to get forward and occupy hostile territory.

We had an excellent demonstration on the island of Pantelleria that by aërial bombardment we can so destroy the defenses on a small target as to render it incapable of further resistance. But it is doubtful if any air force could accomplish the same against an island the size of Sicily or a country the size of Italy. In such cases, men must finally come in with artillery, with something that will accomplish the purposes of the tank, and clear out small and large bodies of defending troops before the country can be considered subjugated.

This brings us to the question with which we started. We have practically reached the limit in the weight and speed of tanks, in the driving power we can put into them, in the firepower we can give them, and the armor we can put on them. Yet we have seen this device, destroyed in appalling fashion in a period of only two weeks in the 1943 German offensive against Russia. It must be admitted also that as a consequence of this slaughter of tanks, the German offensive was broken.

The question then is, *What follows the tank?* The Russians, the Germans, the British, and we know how to destroy tanks in great numbers and quickly enough to break a great offensive. We come thereby to the realization of the point already made, that probably never will human ingenuity be capable of devising anything that further human ingenuity cannot defeat. Having defeated the tank, how shall we compensate for a very vulnerable human body that cannot be armored against the machine gun, hand grenades, shrapnel balls, or shell fragments?

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Editor's Note.—Maj. Gen. C. L. Scott, Commanding the Armored Force Replacement Training Center, Fort Knox, Ky., in an article entitled "Our Tanks Meet the Test," in the January-February 1943 issue of Army Ordnance (Vol. XXIV, No. 136, p. 67) wrote as follows: "The German 88-mm. gun is simply a large-caliber, high-velocity, combination antiaircraft-antitank gun which will knock out, at ranges up to 3,000 yards, any light or medium tank which we, the British, the Germans, or the Japanese can produce. . . . However, this weapon, after all, is merely an artillery piece and can be neutralized and destroyed by counterbattery fire and by machine-gun, infantry, and air attacks. To fight it with these means and not with tanks is simply sound tactics."

# Antiaircraft Artillery

THE effectiveness of America's antiaircraft artillery was conclusively demonstrated in the North African campaign during which over 500 Axis planes were shot down, while similar records have been made in the other theaters in which our troops are engaged. While less glamorous and less publicized than some other components of our Army, the antiaircraft artillery is today playing a most important part in the protection of American troops and the destruction of hostile air power.

The debacle at Hickam Field, Hawaii, and at Clark and Nichols Fields in the Philippines where the Japanese destroyed almost every American plane on the ground, made it clear that adequate antiaircraft defense of airdromes as well as the protection of our forces in the field was a pressing necessity. The problems imposed by time and space are of such magnitude that friendly air power, unless greatly superior to the enemy's, cannot possibly do the job alone. Because of the recognition of the need for positive protection from the ground against enemy air attack, our antiaircraft strength has been increased tremendously during the past nineteen months, and this expansion is still continuing.

Antiaircraft artillerymen and antiaircraft artillery units are trained within the Antiaircraft Command of the Army Ground Forces. Since the activation of the Command in 1942, several hundred thousand antiaircraft troops have passed through its training centers or are now being trained therein. The latter group includes more antiaircraftsmen than there were troops in our entire Army a few years ago. Training facilities include eleven centers located throughout the United States, two service schools, and two service boards.

When the Germans invaded Europe, our few antiaircraft regiments here and in our overseas possessions were equipped with 3-inch antiaircraft guns and with caliber .30 and .50 machine guns on pedestal mounts that limited them to an elevation of only sixty-seven degrees. Today, however, our troops are armed with a variety of antiaircraft guns equaling and usually surpassing any similar enemy weapons.

The caliber .50 machine gun is now installed on single and multiple mounts that permit firing up to 90 degrees elevation. This gun fires about 800 rounds a minute at a velocity of approximately 2,800 feet a second and uses tracer, armor-piercing, and incendiary bullets against low-flying aircraft. The 37-mm. antiaircraft gun and the 40-mm. weapon which has largely replaced it both are rapid-fire, automatic weapons which hurl a high-explosive shell against low- and medium-flying aircraft. The 3-inch gun, formerly our standard heavy antiaircraft weapon, has now been supplanted by the powerful 90-mm. gun mounted on a single-axle, dual-wheel carriage. It fires fixed and individually loaded ammunition at a rate of 120 rounds a minute. High-powered searchlights, sound detectors, and delicate fire-control instruments are used with our antiaircraft guns to insure that their built-in deadliness has its greatest effect upon the enemy. (Illustrations on these pages are from Signal Corps photographs.)

# The Caliber .50 Machine Gun

*The water-cooled caliber .50 antiaircraft machine gun shown above is firing against an aërial target over the desert. This gun, like all our modern antiaircraft weapons, may also be used against hostile ground targets. Below are twin air-cooled caliber .50 antiaircraft machine guns shown in action somewhere in New Guinea. Note the protective armor-plate shield.*

# The 37-mm. Antiaircraft Gun

*The 37-mm. antiaircraft gun was our first modern rapid-fire automatic weapon using a high-explosive projectile against airplanes and it has proved very deadly in battle tests. Mounted on a mobile carriage, as shown above, the gun can be towed at high road speeds and emplaced quickly by raising the wheels and dropping the outriggers, as shown below.*

# The 40-mm. Gun and Its Director

*The 40-mm. gun is mounted on a 4-wheeled mobile carriage and is spring-balanced to enable it to be put into action quickly. It may be used against both ground and air targets as shown in these illustrations. Fixed ammunition is fed to the gun in 4-round clips, and the weapon is operated manually or with a director as illustrated below.*

# The 3-inch—Our Former Standard Heavy Gun

*The 3-inch gun shown on this page was our standard heavy antiaircraft weapon for a number of years and is an effective and efficient weapon at the range for which it was designed. However, since it was unable to defeat the modern fast-flying high-altitude precision bomber it has been replaced with the 90-mm. gun for high-altitude fire.*

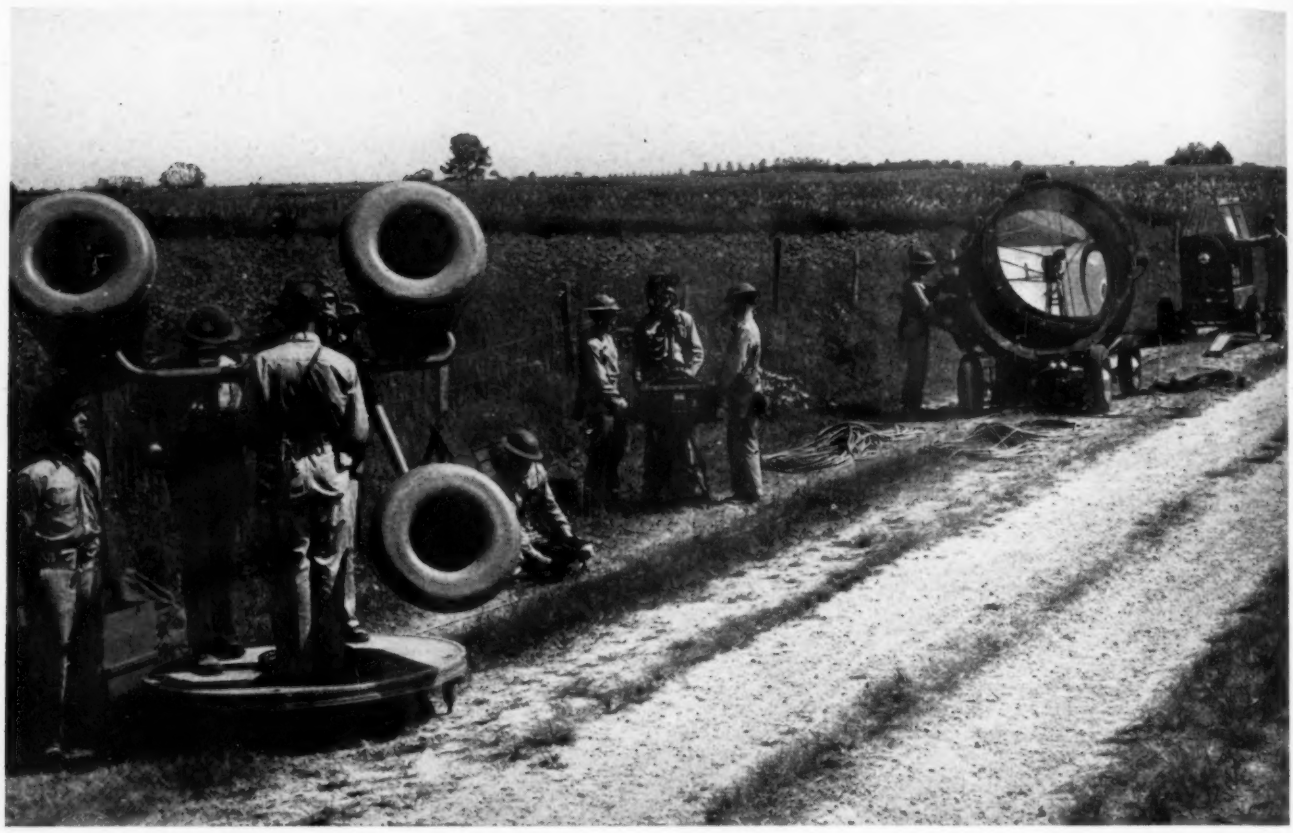
# A New Standard Heavy Gun—The 90-mm.

*The 90-mm. antiaircraft gun is mounted on a single-axle, dual-wheel carriage and is a highly mobile, high-velocity weapon. It fires fixed, individually loaded ammunition and s directed either manually or by remote control. The gun crew, above, is placing the gun in position and detaching the wheels, while below a battery is getting ready to fire.*

## —An Effective Antiaircraft-Antitank Weapon

*The illustration above shows a permanent-type emplacement of the 90-mm. gun with the gun crew and ammunition passers at their stations. This weapon may be used also against ground targets as shown below and has proved a more powerful weapon against armored vehicles than the well-known German 88-mm. gun. Note the size of the shell in the lower picture.*

# Antiaircraft Searchlight and Fire Controls



*Equipment used for detecting planes at night is shown above From left to right are the sound detector, control station, 800,000,000-candlepower searchlight, and power plant. Distances between units normally are greater. Below is shown an armored director which mechanically calculates all data necessary for pointing the gun and setting the shell fuze.*

# Augusta Arsenal

## One Hundred and Fifty Years of Ordnance Service

Col. Gregory S. Lavin

THE establishment known as Augusta Arsenal was originally situated on the Savannah River two miles above what was then the city of Augusta. The reservation consisted of approximately 49 acres which had been purchased by the Government in 1816 at a cost of about $3,350. The first arsenal was garrisoned by a detachment of thirty enlisted men, two lieutenants, and a surgeon and was commanded by Capt. M. M. Payne of the Corps of Artillery.

In 1820, the entire personnel, with the exception of the commanding officer, was wiped out by an epidemic of "swamp fever." Captain Payne, who had been removed to "Bellvue," the site of the present arsenal, miraculously recovered. His recovery led to the belief that the higher altitude, because of its more healthful aspects, was more desirable for the military garrison. Accordingly, on November 9, 1826, the 72-acre tract on which the Augusta Arsenal is now situated was purchased by the Government from Freeman Walker for $6,000.

Construction of buildings on the new site began in 1827. These buildings, for which $49,900 had been appropriated, consisted of two sets of officers' quarters, an enlisted-men's barracks, and a storehouse building—all of which are now standing, in good condition, and in daily use. The buildings were connected by a loopholed wall "for the purpose of security." A gun shed and a blacksmith and armorer's shop were added a little later inside the walls of the quadrangle.

Although the arsenal, according to War Department records, was first established in 1816 as "Augusta Arsenal," it was President George Washington who, in a letter dated March 9, 1793, signed by Henry Knox, then Secretary of War, and addressed to George Mathews, the seventeenth Governor of Georgia (which letter is now in the archives of the state of Georgia), established "a Federal arsenal at Augusta." Application for the establishment of the arsenal, the letter indicates, had been sought from President Washington by several of the delegates to the National Congress to "make provisional arrangement for the calling out of the militia of the neighboring states on the apprehension of danger from the Cherokees. . . . The President of the United States, desirous as far as may be to avert any apprehensions which might arise . . . has directed . . . a small magazine at Augusta of one thousand stand of arms and proportionable quantity of ammunition . . . for the interest of the United States."

PRIOR to the establishment of the arsenal at Augusta by President Washington, the place had been known as "Fort Augusta," where a garrison was stationed. It had been established in 1735 by the trustees of the infant colony of Georgia and was at that time located on the Savannah River in the city of Augusta proper, where St. Paul's Episcopal Church now stands. For a short period during the Revolutionary War, the fort was known as "Fort Cornwallis."

From the year 1828 it is recorded that Augusta Arsenal undertook the repair of small arms for the entire southeastern section of the United States in addition to serving as a fortification for the city of Augusta and the surrounding territory. The arsenal also served as a supply point where unserviceable ordnance material was "turned in to store and new arms furnished in their stead."

Throughout the "nullification troubles," the Seminole and other Indian wars, Augusta Arsenal rendered valuable assistance in the defense of the United States in maintaining and repairing arms, in manufacturing and supplying ammunition, and supplying needed ordnance materials to troops in Florida, Georgia, South Carolina, North Carolina, Virginia, and the entire Southeast.

According to the trends of the times, Augusta alternately contracted and expanded. Additional buildings were erected and additional personnel employed. In 1860, by orders of John D. Floyd, Secretary of War, 22,000 muskets and rifles had been sent to Augusta Arsenal in pursuance of his policy to "fill the Southern arsenals with large quantities of arms and ammunitions." Also in October of the same year, Company "E" of the 2nd Artillery, under the command of Capt. Arnold Elzey, was assigned to the arsenal. The strength of the company was one captain, one lieutenant, and eighty-two enlisted men.

DURING the period of the War Between the States, Augusta Arsenal was greatly expanded. A large brick building was erected, part of which was used as a hospital, part as a storehouse, and the remainder divided into a blacksmith's shop, a tin shop, and a harness and equipment department for field artillery. Paper cartridges were also manufactured in the building from time to time. This building is now known as the general shop building. It has been enlarged and modernized, completely equipped, and is now one of the most up-to-date shops in the Ordnance Department. During the Civil War, several other buildings were erected for the manufacture of cartridges, fixed ammunition, signal rockets, fuzes, primers, grenades, nitric-acid fulminates, and percussion caps.

A chemist was employed, for the local and surrounding territory was found to yield necessary materials to produce in abundance various chemicals for the manufacture of munitions. Machinery and foundry equipment which were capable of using the water power of the Augusta canal were purchased by the Confederate Government. The canal was considered to be a major engineering feat at the time and supplied dependable and sufficient water power. Air and cupola furnaces were added to the foundry, and the machine-shop plant was enlarged. An extensive and complete gun-carriage factory and a powder-box manufactory were established together with several buildings for the preparation of small arms and similar items. The powder works was built during this year on the site of the old arsenal on the Savannah River.

This powder works was at the time the second largest in the world, and its buildings extended two miles along the

Colonel Lavin is the Commanding Officer of Augusta Arsenal.

banks of the Augusta canal. Two hundred and twenty acres of land had been purchased adjacent to the old arsenal site and storehouse buildings of substantial structure erected of brick and granite at intervals of a thousand feet to insure safety in the event of explosions. Thus, Augusta Arsenal expanded to become a veritable fortification of the city of Augusta. It comprised a chain of works, beginning at the Savannah River east of the eastern boundary of the city and extending crescentlike around the town to the powder works on the western boundary. There were ten earth forts, and an inner line of defenses extended in the "commons" or between what are now Gwinnett and Fenwick Streets on the south side of the city. Augusta Arsenal had no manpower shortage during the crucial years of the Civil War. It proved that it was capable of manufacturing, repairing, maintaining, and supplying all types of ordnance material, including ammunition, in large quantities for the Southern sector. It further proved the value of its strategic location in regard to transportation facilities. It is recorded that between twenty-five and thirty thousand pounds of powder were turned out from the gunpowder mill in a single day. Among other items of manufacture were 12-pounder Napoleon guns, carriages, shot and shell, hand grenades, battery wagons, caissons, canteens, sensitive tubes, friction primers, signal rockets, etc.

As a memorial of the days of the Civil War, four brass cannon which were made from the church bells of New Orleans, Charleston, and other Southern cities now stand near the officers' quarters and the headquarters building at Augusta Arsenal. These cannon were originally presented to Sample's Battery, later captured by the Federals, and after the war were sent to Augusta Arsenal for decorative purposes. An interesting sidelight of the defense of Augusta is contained in the statement that the Savannah River was "protected against enemy vessels by submarine torpedoes placed at Shell Bluff."

Records of arsenal operations after the middle of 1862 and until the close of the Civil War are scant. In May 1865, the arsenal was surrendered to Brig. Gen. Emory Upton, U. S. Army, and United States troops were again stationed at the arsenal which had once more become an Ordnance Department station. Through the long, lean years of the Reconstruction period, the arsenal remained a much-loved and highly important institution of this section. Gradually the personnel was decreased until but a skeleton force remained.

THE Spanish-American conflict again emphasized Augusta Arsenal's ability to render valuable assistance to troops, and from the early part of the present century there has been a steady gain in equipment and facilities as well as in trained personnel with a resulting expansion of activity. The arsenal manufactured large quantities of cavalry equipment, seacoast targets, etc., and served what was then known as the South Atlantic District.

The outbreak of World War I found Augusta Arsenal well stabilized and efficient. Activity was rapidly increased, new departments were set up in the shops, and an additional thirty-three acres of land were leased at the Harrisonville Yards on the Georgia Railroad where warehouse buildings were constructed and the Augusta Ordnance Depot Annex of the arsenal was established. Additional machinery and equipment were installed in the shops, a large corps of expert machinists was employed, and the supply of equipment to troops was expanded. A thoroughly efficient foundry was in constant operation, and it is estimated that approximately 500 pounds of brass castings were manufactured daily as well as a quantity of white metal which was fashioned into range drums used in connection with seacoast artillery.

SITUATED in the heart of a leading lumber and textile district, the arsenal was well suited for the manufacture of targets and target material, and its easy accessibility to metal-working industries made it a strategic point for the manufacture of castings. After the Armistice, the arsenal, like all other establishments throughout the country, suffered a reduction of force and activity, until, during the period of "disarmament" and "economy," its personnel again became a skeleton force "to keep alive a knowledge of the procedure of maintenance, repair, and overhaul of ordnance matériel" and to serve the field in the Fourth Corps Area.

The national "relief" agencies, WPA, etc., contributed to the modernization of Augusta Arsenal by paving roadways, remodeling, painting, and otherwise improving buildings at both the arsenal proper and the Augusta Ordnance Depot, located three miles distant on the tracks of the Georgia Railroad.

The optical shop, which had been established shortly after the close of World War I, became a most important function of the arsenal, and the small force employed for this highly scientific work became efficient and well trained.

In the early part of 1942, additional warehouses and shop buildings were erected on the 70-acre plot which constitutes the arsenal proper. A new optical building was erected and the force in that shop expanded from a mere handful to approximately 150 employees. It became a training center for optical and instrument repairmen from all sections of the country, at the same time accomplishing repair, modification, overhaul, and maintenance of all types of optical and fire-control instruments for the using services. Women and physically handicapped persons were employed and trained with signal success. In all departments of the arsenal expansion was rapid and efficient, and the increased mission of the arsenal was accomplished with speed. In many departments, operations were carried on twenty-four hours a day.

At the present time, both the arsenal and the depot annex are fulfilling a strategic and important mission in the service of supply. The optical department is one of several outstanding functions of the arsenal, and its small-arms repair section, machine-gun shop, general machine shops, carpenter shop, flag and leather shop, forge shop, receiving and issuing storehouses, etc., are well equipped and modern in every respect and are capable of performing assigned orders efficiently and expeditiously to serve well the needs of our modern Army in World War II.

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EDITOR'S NOTE.—For further information on the Ordnance establishments, readers are referred to "Mechanized Ammunition Manufacture" (Picatinny Arsenal), by Col. William E. Larned, in the May-June 1943 issue of ARMY ORDNANCE (Vol. XXIV, No. 138, p. 504); "Ordnance Pacemakers" (short histories of Frankford, Picatinny, Rock Island, Watertown, and Watervliet Arsenals, Springfield Armory, and Aberdeen, Erie, and Jefferson Proving Grounds) in the November-December 1942 issue (Vol. XXIII, No. 135, p. 505); "New Guns for America" (Watervliet Arsenal), by Brig. Gen. A. G. Gillespie, in the November-December 1942 issue (Vol. XXIII, No. 135, p. 475).

# Civilian Automotive Advisors

## Motor Specialists Aid the Army's Maintenance Training Program

James A. Bell

IT was late in the afternoon one December day at Fort Riley, Kans., as the Ordnance officer of the 9th Armored Division gathered a group of fifteen civilian automotive advisors around him. The division possessed a few cavalry stables but no classrooms, no instructional equipment, not even a detailed maintenance-training plan. The Ordnance officer knew that, and he asked the fifteen civilian advisors to help set up a school within *one* month to begin turning out second-echelon automotive mechanics from green troops. The advisors came through for the division—right on the deadline. And that's the sort of problem the Army's 1,800 civilian automotive advisors have been solving in divisions and units all over the country for the past year and a half.

The advisors were hired early in 1942 to bolster the Army's huge training program for drivers and mechanics in the units. The first indication that the Army might have to call for help in maintenance training came in the 1941 Louisiana maneuvers. When those serious games were over, the staffs leaned back and looked at the results. They noted the higher echelons of maintenance were overburdened because of the lack of first- and second-echelon maintenance. A committee of motor and transportation specialists were working under G-4, War Department General Staff, during these maneuvers looking for a way to cut down the serious vehicle losses, and they pointed to the lack of training as the big reason for weak organizational maintenance.

It was understandable, for in those days our war machine had only recently shifted into high, and in that acceleration the time for training was cut down until it was spread gasket-thin. What suffered most through this reduced training program was, of course, the maintenance of Army vehicles. Lack of preventive maintenance became the grim vehicle reaper. Many repairs within the scope of the organizational mechanic were being sent on to higher echelons because drivers and mechanics simply didn't know better. Training was the solution. Who could do this training job better, the War Department General Staff reasoned, than the few men in civilian life who had made a career of maintenance as service managers for commercial fleets, as service engineers for bus companies, as service managers, and as specialist mechanics.

Since the majority of these men were draft exempt, the General Staff recommended that they be hired under Civil Service. As an experiment, the first group of civilian automotive advisors put down their luggage at Camp Edwards, Mass., on February 26, 1942, to begin work with the 26th Infantry Division. They were a strange group that day who gingerly approached a tank, adjusted their bifocals, and wondered which end of the vehicle had the hood!

But it wasn't long before the effect these specialists had on maintenance was felt in the division, and the Army took the cue from that test. It was an indication of how maintenance standards could be improved in all divisions. The civilian automotive advisor program was off to a galloping start. Immediately, with the help of the Civil Service Commission, the Army set out to obtain the cream of industry's maintenance brains. Eighteen-hundred of these men who met the stiff standards of Civil Service were put on the Army pay roll. The selectees were grouped by the Commission into several salary grades depending on whether they had 6, 7, 9, 10, or 11 years of experience, on their education, and other factors. The highest group were called Chief Automotive Advisors—CAF-13 (CAF is the formal job grouping used by the Commission for all clerical, administrative, and fiscal employees). Other titles were: Head Automotive Advisor—CAF-12; Principal Automotive Advisor—CAF-11; General Automotive Advisor—CAF-9; Associate Automotive Advisor (spare parts)—CAF-8; Junior Automotive advisor (spare parts)—CAF-7.

DIRECTION of the program was now centralized in the Ordnance Department's Civilian Automotive Advisor Unit—a part of the preventive-maintenance section, Maintenance Branch, Tank-Automotive Center, Detroit. Divisions in the field needed the advisors urgently, and they got them immediately—in most cases, fresh from civilian life. Here again the bugaboo of "lack of training" rose up. This time the training involved the advisors. They needed more information about their job with the Army. Here they were assisting and advising military personnel and yet were not sure of the military policy on maintenance. Advisors needed to know about the echelons of maintenance, about the characteristics of combat vehicles, about the official publications for use in training, about Army organization, and about the most efficient ways to instruct.

The Civilian Automotive Advisor Unit asked that a special one-week indoctrination course for advisors be given at the automotive schools at Holabird Ordnance Depot, Atlanta Ordnance Depot, Fort Crook Ordnance Depot, Stockton Ordnance Depot, and San Antonio Ordnance Center. Army Ground Forces and Army Air Forces saw eye to eye with the Ordnance Department, so each week a different group of advisors were given leave from their units and assigned to the schools. Just a few at a time were sent so the unit's advisor strength would not be weakened too much. In some units the Ordnance officer and the motor officers went along and carried schoolbooks right with the advisors. The officers also benefited by learning about the advisor program and how they could use the men more effectively. Both advisors and officers usually completed the course with new understanding and appreciation for each other's jobs.

Let's go along with a group of advisors, now fully indoctrinated and ready for action, to see just how they mesh with military personnel in an Infantry division. The official table of allotment (Fig. 1) shows only the maximum number of advisors units may have and what grade they must be. In the Infantry division the team has twelve advisors who came to the division at the request of the division commander to the commanding general of the service command. (Recently, a cadre of two advisors is being assigned to each

Mr. Bell is chief of the Civilian Automotive Advisor Unit, Maintenance Branch, Tank-Automotive Center, Detroit, Mich.

| | ARMY GROUND FORCES | | | | | | | | | | | | | | ARMY AIR FORCES | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Grade | Infantry division | Motorized infantry div. | Cavalry division | Armored division | Army corps (*a*) | Armored corps (*a*) | Field army (*a*) | Armored Force hq. (*a*) | Service command | Port of embarkation | Defense command (*b*) | Tank destroyer bn. | Tank battalion | Commands: Repl. & Sch., Antiaircraft (airborne), Amphibious, Tank Destroyer, and Engineer Amphibian | Hq., Army Air Forces | Hq., AAFASC | AAFASC Districts | Air Force, AAFMC, AAFATC, AAFTTC, AAFFTC, & Training Command | Bases and stations |
| CAF-13 | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | *b* | 1 | | | | |
| CAF-12 | 1 | 1 | 1 | 2 | | 2 | 18 | 4 | 1 | 3 | *b* | | | *b* | | 1 | 1 | 1 | |
| CAF-11 | 5 | 3 | 4 | 3 | | 2 | 26 | 4 | 3 | *b* | 2 | 1 | 1 | *b* | | | | | |
| CAF- 9 | 5 | 9 | 11 | 8 | 29 | 2 | 16 | 12 | 5 | 1 | 14 | 1 | 1 | *b* | 1 | | 1 | | 1 |
| CAF- 8 | | 1 | 1 | 2 | | 1 | 17 | 4 | | *b* | *b* | | | *b* | 1 | 1 | 1 | | |
| CAF- 7 | 1 | 1 | 1 | | | | *a* | 1 | | *b* | *b* | | | *b* | | | | | |

(These allotments are made to cover funds for payment of personnel. Selection of men should be made to cover needs of each unit.)

*a*. This allotment to be drawn against as needed for corps or army units on the basis of one CAF-11 or CAF-9 per separate battalion or regiment plus necessary overhead. Upon request to The Adjutant General through channels, changes in present allotments may be made.

*b*. Requests will be submitted to The Adjutant General by the commanding general for the necessary allotments. Requests will be based upon use of one CAF-11 or CAF-9 as instructor with each second-echelon shop per separate regiment or battalion.

*—(Adjutant General Directive—AG 210.61 Gen. Staff (6-9-42) MT-D-PS-M)*

Fig. 1. Official Table of Allotment of Automotive Advisors by Units

newly activated division. The cadre later assists the Ordnance officer in filling out his complete advisor team.)

The lone CAF-12, head automotive advisor for the division, works right along with the division Ordnance officer (see Fig. 2). It is the logical place for the head advisor since the Ordnance officer supervises training for maintenance in all echelons. Nine of the other advisors are usually placed with the Infantry regiments, the Field Artillery battalions, and the separate companies (Fig. 2). The remaining two advisors work with the military personnel in the Ordnance light-maintenance company. One is a general automotive advisor who assists the officer in charge of the automotive platoon with the third-echelon work of the division. The other is a junior automotive advisor (spare parts) who assists the officer in charge of the supply platoon in setting up the parts system for the division.

In each of those cases the advisors sleep and eat with the officers of their unit, as well as work with them. The head advisor, in working with the division Ordnance officer, is in a good spot to coördinate and direct the division's advisor program. One way he coördinates the program is by holding regular advisor meetings to keep all the advisors informed of new publications, policies, and directives, to thrash out any training problems the advisors have, to correct any maintenance deficiencies reported, and so on. As assistant to the Ordnance officer, he often is authorized to observe how maintenance and maintenance training are being carried out in the division. While the head advisor helps form the maintenance-training policy, in conjunction with the division Ordnance officer and G-3, the advisors in the division's units carry it out. The principal automotive advisor in one of the Infantry regiments, for example, does the actual training of the troops in line with the approved plan.

THAT word "training" is the key word in the list of advisor duties. For through his teaching the automotive advisor is performing the function for which he was originally chosen; namely, to pass on to the men in the Army the knowledge he has gained through years and years of experience in automotive maintenance. A day's work by this principal advisor with one of the Infantry regiments might begin by a conference with the motor officer. The officer and the advisor peruse the fistful of requisitions for sending vehicles to the Ordnance light-maintenance company to see if any of the jobs fit within the limitations of second-echelon tools, parts, and personnel. Later in the morning, the advisor is scheduled for a get-together with the mechanics to go over the procedures for 1,000-mile

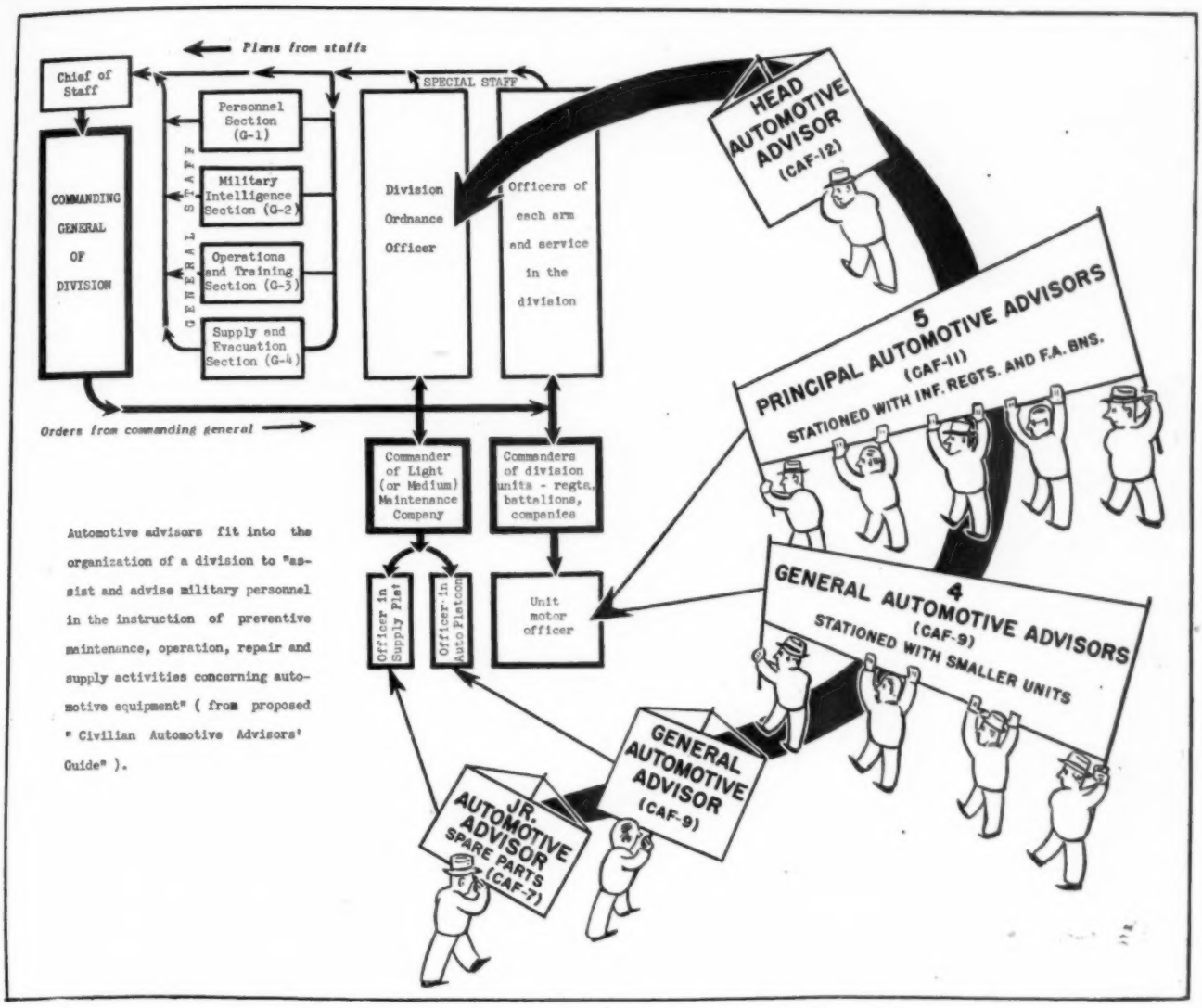

Plans from staffs
Chief of Staff
COMMANDING GENERAL OF DIVISION
GENERAL STAFF
Personnel Section (G-1)
Military Intelligence Section (G-2)
Operations and Training Section (G-3)
Supply and Evacuation Section (G-4)
SPECIAL STAFF
Division Ordnance Officer
Officers of each arm and service in the division
Orders from commanding general
Commander of Light (or Medium) Maintenance Company
Commanders of division units - regts, battalions, companies
Officer in Supply Plat
Officer in Auto Platoon
Unit motor officer
Automotive advisors fit into the organization of a division to "assist and advise military personnel in the instruction of preventive maintenance, operation, repair and supply activities concerning automotive equipment" ( from proposed " Civilian Automotive Advisors' Guide" ).
HEAD AUTOMOTIVE ADVISOR (CAF-12)
5 PRINCIPAL AUTOMOTIVE ADVISORS (CAF-11) STATIONED WITH INF. REGTS. AND F.A. BNS.
4 GENERAL AUTOMOTIVE ADVISORS (CAF-9) STATIONED WITH SMALLER UNITS
GENERAL AUTOMOTIVE ADVISOR (CAF-9)
JR. AUTOMOTIVE ADVISOR SPARE PARTS (CAF-7)

FIG. 2. DISTRIBUTION OF AUTOMOTIVE ADVISORS OF THE VARIOUS GRADES

maintenance using the new work sheets (W.D., A.G.O. Form Nos. 461, 462, 463). In the afternoon, the advisor goes with the unit on a tactical exercise being given as part of the Mobilization Training Program. The advisor studies the performance of the drivers and mechanics to see if any weak points show themselves under the conditions of the exercise. The advisor finishes off the day by cleaning up some of his paper work and planning future instruction.

When the division is ordered to the staging area, the advisors pack up their bags. Advisors don't go overseas—they are for use in training only. A Ground Forces ruling allows advisors to stay with the unit no longer than a year, regardless of how long the training period is. The reason for this rule is a serious caution to all advisors: All instruction and advising should place the emphasis on letting the troops do the work so that when the soldiers are in the combat zone they will be self-reliant in maintenance. Advisors in the field assure this by keeping in the background and by acting as instructors, not mechanics.

Recently many advisors have been reassigned from units activated and sent overseas. They bring accounts of the work done in divisions. One division authorized the advisors to set up a program which would make every man a driver. Their school handled 600 soldiers at one time, and they went a long way toward putting life into their slogan: "The Cargo Must Go Through." In another division, vigilant first-echelon maintenance plus the work of advisors resulted in only 0.3 per cent deadlined vehicles.

Reënforcing these examples are the statements of some of the Army's commanders. Lieut. Gen. Lesley J. McNair, formerly commanding the Army Ground Forces, in a letter to the chief of the Civilian Automotive Advisor Unit, on December 29, 1942, stated: "The automotive technicians are a new element in our training activities and have made marvelous headway in a surprisingly short time. All commanders are enthusiastic in their praises of these unusual men. Their effect on maintenance has been startling. My only concern is that units will lean on them too heavily and not develop officers and enlisted personnel capable of taking over when the technicians pass on to other units."

In a letter to *Army Motors,* February 1943, General McNair wrote: "Civilian automotive technicians have done a fine job, and deserve much credit for the improvement [in motor maintenance]. In most cases they are being used properly—as instructors of military personnel, not foremen, executives, nor mechanics. The unit personnel must learn a maximum from them during their stay with the unit, and become independent of them as soon as possible."

# The New 75-mm. Aircraft Cannon

*Field artillery has been given wings with the development of this fast-firing 75-mm. aircraft cannon shown above installed in the nose of a North American B-25 Mitchell medium bomber which was redesigned for its new rôle. A metal nose replaces the bombardier's glass compartment, and two caliber .50 machine guns also have been added as shown below.*

# The Industry-Ordnance Team

## Success of the Government-Owned, Contractor-Operated Plants

WHEN, in 1940, the Ordnance Department was faced with the problem of manufacturing armament to provide for the needs of an impending war, it called in the representatives of industry for advice and help. It was soon apparent that existing facilities in privately owned plants were inadequate to provide "enough and on time"—even working to full capacity and on a 24-hour basis. The result of these conferences was the decision to build Government-owned, contractor-operated plants for the necessary ordnance matériel to meet the requirements of the Army supply program.

Illustrative of the problems and success of such manufacturing facilities are the following accounts of the Denver and Allegany Ordnance Plants. These accounts are the first of a series to be published in ARMY ORDNANCE on the organization, development, facilities, and operation of the "new" Ordnance establishments—those Government-owned, contractor-operated plants which have come into being to meet the armament needs of World War II. The present discussion is a most appropriate introduction to the series since it treats of the development and operation of two Ordnance plants under almost exactly opposite conditions. The Denver Plant was planned from its very inception as a modern, mass-production small-arms-ammunition facility, embodying all the improvements and safety devices that science could provide. On the other hand, the Allegany Plant was converted to small-arms-ammunition production from a tire manufactory, its operations were tailored to meet the restrictions of its location and equipment, and, having served its purpose, it has been reconverted to its former use. Both plants fulfilled or surpassed their production quotas, and both contributed greatly to the victorious record of our troops in this war.

### Denver Ordnance Plant

*Lieut. Col. Seth Wiard*

THE Denver Ordnance Plant, located about seven miles west of the city of Denver, Colo., was one of the first new small-arms-ammunition plants to be implemented and is one of the largest plants in the world devoted solely to the manufacture of caliber .30 ammunition. It is operated by the Remington Arms Company, Inc., an industrial manufacturer with a history of supplying arms and ammunition for the United States in five wars.

In the fall of 1940, a site board, composed of Remington executives and officers from the Office of the Chief of Ordnance, selected for the plant site a large portion of what was then the Hayden Ranch. This ranch area, which dated back to pioneer days, runs directly to the foothills on the eastern side of the Rocky Mountains, and the plant location as finally determined embraced about 2,000 acres of this property.

From land which was nothing but picturesque rolling pasture where herds of white-faced Hereford cattle roamed, a manufacturing plant was built and put into production in seven months. There are now more than 200 modern, functional buildings which resemble schools or sanataria. The roof area alone occupies 35 acres. Here there are 7 restaurants, serving 20,000 meals a day, a police force larger than that of the city of Denver, a railroad system with more than 11 miles of track, more than 17 miles of roadway facilities, and a hospital with the finest appointments. All this arose from farmland in seven months; yet the plant was not hastily erected as a temporary installation.

THE contract drawn between the Ordnance Department and the Remington Arms Company was on a cost-plus-a-fixed-fee basis. That is to say, the plant in its entirety is owned by the Government, even to the lead pencils used, and is loaned, so to speak, to the contractor for his use in manufacturing ammunition. All costs encountered in the manufacture of the product, as defined within the terms of the contract, are assumed by the Ordnance Department, and the operator is paid a fixed fee based upon the actual amount of ammunition accepted by the Ordnance Department. The advantages of this procedure lie primarily in the closer control which the United States Government is able to exercise over the expenditure of money and the cost of manufacture.

Once the site was decided upon and the contractor secured, the construction contractors were selected, and they immediately set up offices to start gathering around them the staff needed to accomplish the project. Never before had the Denver area been met with a similar task. The scope of the job was tremendous considering actual size, material required, labor, technicians, construction men, and similar requirements. No single firm in the Rocky Mountain area could ever have accepted it. What actually happened was that two men with long construction backgrounds organized and developed a staff specifically for the purpose.

On March 16, 1941, ground was broken. Herds of cattle had to be segregated and driven to an area where they would not interfere with construction activities. Power lines, water, utilities in general—all had to be brought in. Yet the work started and never ceased. Twenty-four hours a day men toiled. Giant floodlights flared at night lighting the area like a gigantic carnival. Original plans called for the huge task to be completed in twelve months—an unheard rate of speed. Actually, it was essentially complete and production had commenced seven months from the starting date. During no phase of this 7-month period was work curtailed. There arose no labor difficulties, acquisition of material was unhampered, and schedules were more than met. Only one adverse spell of weather succeeded in hampering operations, and then not materially. Ninety per cent of the construction personnel required was recruited from the labor markets of the region. At one time, over ten thousand persons were engaged in construction work alone. So the plant rose to become one more link in this Nation's gigantic war effort.

The Denver area was not an industrial area. There were no large factories, no large commercial enterprises, and consequently no factory personnel. The people of the area had no knowledge or concept of working, thousands together, in a centralized area and on one commodity geared to the acme in mass production. Yet they were to be the ones to man this

new plant, for labor could not be imported to do it. Faced with the vast production of military cartridges which he had assumed and a labor market composed entirely of personnel to whom factory work was completely alien, the operating contractor was faced with the necessity of training key personnel in methods and standards of this work—and as quickly as possible.

Steps to provide this training were initiated at the same time that construction commenced. Those chosen for the training were not persons with experience in ammunition manufacturing, because there were so few of these, but persons with an adaptable background. These men were selected and sent for approximately four months to a training school at the operator's parent plant. Here this carefully selected personnel garnered knowledge, experience, and background for the positions they would eventually assume. All were taught to operate as a staff so that at the end of their training they were equipped and ready to begin production. These men eventually were utilized to train the rank-and-file worker with whom the plant would be manned for the mass production of small-arms ammunition.

SOME BUILDINGS ON THE HAYDEN RANCH

Designs for the plant were well under way before construction started. The specifications provided for five manufacturing buildings and all necessary auxiliary buildings. All manufacturing buildings are of identical design, being one-story each with a two-thirds mezzanine. The machinery is set in banks logically proceeding from one step to the next advancing step in the manufacturing operation. The mezzanines are utilized to locate all correlated equipment identified with each major process which includes the requisite annealing furnaces, washers, and similar equipment. All major steps and correlated equipment are supplied by an elaborate, endless-belt, hopper-conveyor system which receives the uncompleted component from any one step and carries it to the next substep or major process in the operation. Thus, the developing cartridge moves along, upstairs and down, one process to the next, through this labyrinth of canvas belts and hoppers, virtually untouched by human hands from the time it enters the first process until it emerges a finished component.

The reservation itself is laid out in identified areas, each segregated from the others by nature of its location and fencing. There is the manufacturing area composed of all manufacturing buildings and sundry auxiliary buildings such as the firehouse, warehouse, powerhouse, garage, and proof-firing building; the hazardous area which surrounds powder-storage magazines, powder-mixing buildings, the primer-manufacturing area, and primer-drying and storage areas; finally there is the administrative area wherein are located the several buildings housing the offices which direct the operation of the plant.

The buildings are of brick and reënforced concrete, some being finished inside with cinder block. Floors are hardwood laid in parquet design to lessen fatigue from standing. Each of the manufacturing buildings is complete within itself from receiving and warehouse facilities to packing and shipping areas and is equipped with complete service facilities including a hospital and a cafeteria. The entire plant is serviced from one central power and heating unit and from centrally located utilities distribution units.

CONTINUALLY since the start of operations the daily running capacity of the plant has exceeded the rated capacity for which is was designed, and its actual capacity has not yet been reached. The reasons for this are somewhat apparent. In the relatively crowded areas of many of our industrial centers, what building space is available has to be utilized to the utmost, sometimes disregarding efficiency. Hence, the design of a building is materially affected by the available space and to a lesser degree by the needs of the product to be manufactured. At the Denver Ordnance Plant it was not necessary to conserve space; consequently the design of the buildings could be determined entirely by the needs of the product to be manufactured. Then, too, most of our existing ammunition-manufacturing facilities started with a building or so and "jest growed" like Topsy as requirements dictated. This prevented centrally planning each unit in relation to other units, and the sacrifice of a certain efficiency and economy of operation had to be accepted. Such was not true of the Denver Ordnance Plant. It developed and grew from a well-planned scheme. This schematic planning and new equipment seem to answer why the designers did not accurately prognosticate the productive capabilities of the establishment.

The plant is engaged solely in the manufacture of caliber .30 ammunition, four types being produced—ball, armor-piercing, tracer, and incendiary. The majority of the essential components for all these are processed on the plant site from raw materials. Each of the manufacturing buildings contains a complete production line for the manufacture of the ammunition with the exception of the primer and lead slug which are supplied to it by other units on the reservation. Cases are processed from case cups through the final operation, including primer insertion. Bullets are processed from the bullet cup through final bullet assembly, and loading is accomplished in each building. One building on the plant is utilized for the production of primers for supply to all manufacturing operations. In this building, primers are processed from brass strip through to the completed item including cup stamping, charging, foiling, and anvil stamping and insertion.

The Ordnance Department concerned itself with produc-

tion quotas, determination of the needs for all Government-issued production materials and other materials of a critical nature, the causes for production delays, the acceptance of completed ammunition, the coördination of efforts when material allocations became effective, and many other factors. Steps were taken to anticipate and provide for shortages of critical tools, machines, and materials. Constant urging was maintained and aid given to keep every unit and every machine in full operation. Yet, at the same time, the strictest inspection standards were maintained, and a satisfactory record for quality ammunition was established.

Now the Denver Ordnance Plant is a going concern. In its short life much has been experienced and much has been learned. The personnel of the plant know from experience that the combined efforts of Government employee and contractor employee can be coöperatively united and pooled. That this is true is evidenced by the fact that the plant won the coveted Army-Navy "E" award for excellence less than a year from the date production began and, within another year, earned its first star to this award for continued excellence. This could never have been achieved except for the coöperative relationships of all persons and the efficiency in operation of the contractual agreement.

DENVER ORDNANCE PLANT RISES ON THE RANCH SITE

The history of this establishment, along with numerous other war industries, illustrates that the ingenuity and endeavor of a free people in pursuing a democratic way of life will meet all challenges and points to continued victories in securing the preservation of American ideals.

## Allegany Ordnance Plant

*Maj. E. J. Hill*

IN the fall of 1941, the War Department decided that a fourth wave of small-arms ammunition plants would have to be constructed to meet future requirements. Since the need of these plants might be eliminated overnight through some change in the fortunes of war, it was required that construction be in accordance with the "bare-necessities" plan. This plan called for a minimum amount of construction which would be of a temporary (5-year) type and limited to only the essential requirements.

The Ordnance Department recognized that hazards were present in the handling of explosives and decided to accept certain risks, the extent of which were defined by Ordnance safety manuals and bulletins. In the spring of 1942, a meeting was held at Kings Mills, Ohio, attended by representatives of the Engineer Corps, Ordnance Department, architect-engineers, and operators in order to establish the minimum requirements necessary to meet all the safety requirements of Ordnance and the Engineers. Under the final plan, all designs and layouts were to be kept as simple and compact as possible to minimize the use of critical materials and utilities. Appearance was not important, and, wherever possible, wood-frame structures of the most economical designs were to be used. The plan went so far as to eliminate entirely the use of galvanized metal and lightning protection and permitted only the minimum use in the essential places of fluorescent lighting, sparkproof floors, and barricades.

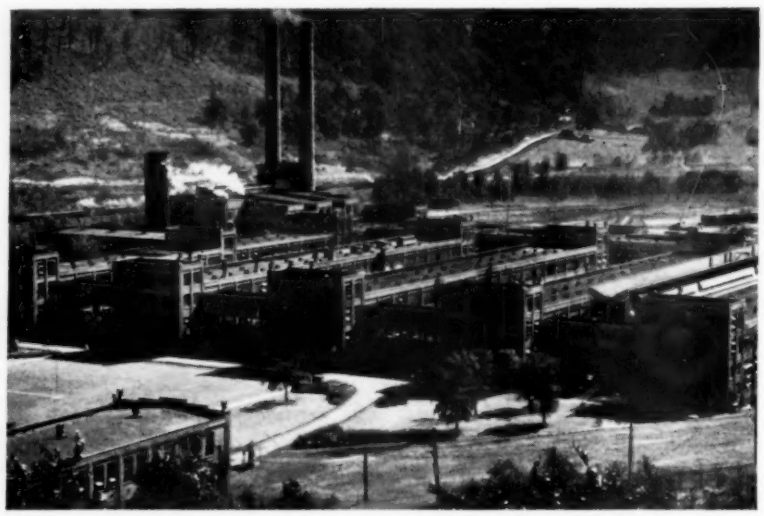
In the search for available buildings, the factory of the Kelly-Springfield Tire Company, Cumberland, Md., was considered as a likely facility since the shortage of crude rubber had caused this company to discontinue the production of automobile and truck tires and tubes. The main building consisted of a header building and five wings, with two floors, basement, and partial mezzanine. The tire company convinced the Government that it could furnish an organization capable of operating a manufacturing facility and also more than half a million square feet of floor space by storing part of its tire equipment in one end of the building and shipping the remainder to another subsidiary of the parent company. Another point in favor of this locality was the fact that Cumberland was the focal point of a wide area, including many small towns, which contained little manufacturing except in Cumberland itself which had four main industries, one of which was the Kelly-Springfield Company. As no new manufacturing had been started in this area, the labor supply was good, and the housing was adequate to handle the influx of labor caused by a new industry.

Because small operations in rubber were to continue, and a contract for artillery shells for the Pittsburgh Ordnance District was in operation in the same building, the Kelly-Springfield Company on March 16, 1942, organized and incorporated the Kelly-Springfield Engineering Company, under the laws of the State of Maryland, to operate the Allegany Ordnance Plant. The engineering company then leased from the tire company the available buildings for the manufacture of small-arms ammunition.

In April 1942, the engineering company entered into a formal cost-plus-a-fixed-fee contract with the United States Government "to furnish consultant service covering consultation with and advice to the architect-engineers and constructor regarding the adequacy of design, engineering, and construction; procure equipment and install such equipment at the project; and operate the new Ordnance facility for the manufacture of caliber .30 ammunition." At this time, both the Ordnance Department and Engineer Corps set up organizations at the plant to handle their respective parts of the program. Already an industrial engineering firm had been engaged for over a month on a survey of the plant facilities for conversion from the manufacture of rubber products to small-arms ammunition and to estimate the amount of equipment that could be installed in the productive areas of the leased

facilities and utilized at maximum efficiency. This survey indicated that it would be impractical to carry out all the operations of ammunition manufacture at the tire plant, since it lies on a relatively level area of approximately forty-three acres located in the southwest section of the city of Cumberland.

It was decided that all hazardous operations except loading were to be performed elsewhere, so a 425-acre farm, located nine miles southwest in the State of West Virginia near the town of Pinto, Md., was bought by the Government, and on it were constructed buildings for powder storage, chemical storage, primer mixing, primer charging, primer storage, proof testing, and a firehouse and garage. The only items of major construction other than utilities and general repairs made at the Cumberland plant were a loading building, four small explosives-storage buildings, and a salvage shed. The conversion of the main plant and the construction at both sites were accomplished under contracts independently let by the Corps of Engineers who supervised design and construction. Construction was begun in May 1942, and the entire project at both the Cumberland and Pinto sites was completed by February 1943.



KELLY-SPRINGFIELD SITE, ALLEGANY ORDNANCE PLANT

DURING the activating period of the small-arms ammunition plants, all production machinery was anticipated, ordered, and allocated by the Small Arms Ammunition Branch, Office of the Chief of Ordnance, with a view to obtaining production as fast as possible. The first carload of production machinery was received in mid-June 1942, and each day thereafter saw continued deliveries and installations. On July 10th, the Ordnance Department advised the engineering company that the contract was being changed from the manufacture of caliber .30 to the manufacture of caliber .50 ammunition. This necessitated the transfer of equipment on hand to other Ordnance plants, the cancellation of existing orders for machinery, tools, dies, gages, and the procurement of similar equipment for manufacturing caliber .50 ammunition. The first delivery of caliber .50 production equipment arrived in the latter part of August. Originally, production was to have commenced on August 15th; however, because of the conversion to caliber .50 ammunition, production did not get under way until the last of October.

The production of small-arms ammunition was a new manufacturing process to the tire company's organization and to the labor in that area; hence, it was necessary to train sufficient personnel in the various operations. This was accomplished during the construction period by sending approximately 150 men to the St. Louis Ordnance Plant, St. Louis, Mo., and approximately 375 men to Frankford Arsenal, Philadelphia, Pa., for periods varying from 4 to 8 weeks, for training as foremen, supervisors, adjusters, inspectors, etc. This group, along with the key personnel, such as administrative, planning, purchasing, engineering, expediting, and maintenance personnel who had been transferred from the tire company at the beginning of the contract, formed the nucleus for the company's organization. By August, the organization was ready to commence production and handle the task of hiring and training new personnel as needed. The prime raw materials—case and jacket cups, cores, powder, primer and anvil brass—were easily procured by the contractor's organization since these were allocated to the plant by the Small Arms Ammunition Suboffice. This offered the best solution for all the small-arms-ammunition plants as it equalized distribution and prevented any bottlenecks or out-of-balance conditions.

The first car of ammunition was not shipped until November 30th; however, in December and every month thereafter the production schedule set by Ordnance was met or exceeded except during the month of February 1943, when manufacturing difficulties were encountered and output fell short approximately thirty per cent. Maximum scheduled production was reached in July, at which time employment exceeded the 5,000 mark, approximately 50 per cent of the employees being women.

In February 1943, the Ordnance Department began to negotiate for a fifty per cent increase in the capacity of the plant. The formal agreement was reached in March, and orders were placed immediately for the additional equipment. In the second week in June, this expansion program was canceled, and there followed the necessary cancellations and dispositions of orders and equipment.

JULY found the synthetic-rubber output of the country exceeding the consuming capacity of the rubber-processing facilities, so the War Department was asked to consider the release of certain rubber facilities which had been converted to the manufacture of ammunition. From the rubber standpoint, the reasons for reconversion were twofold: first, it eliminated new construction, and, secondly, it made available trained rubber workers who were employed on the ammunition-production lines. The War Department felt that it could consent to this conversion since it fitted in very well with the changes in military requirements. A study by the Ordnance Department indicated that small-arms-ammunition requirements could be met by the increased efficiency in the facilities constructed originally for that sole purpose; so on August 26th the Kelly-Springfield Engineering Company was notified that the contract would be terminated on or about September 30, 1943, and a termination letter was received later confirming that date.

In the termination of a cost-plus-a-fixed-fee contract, five main problems of greater or lesser importance are involved, and these are tied together by the articles of settlement in the

contract, Ordnance procurement instructions and procurement regulations. These problems are: (1) The discontinuance and settlement of all subcontracts, leases, purchase orders, commitments, etc.; (2) The cessation of manufacturing operation; (3) The termination of employees; (4) The disposition of Government property—real, industrial, miscellaneous, and military; (5) Compensation of the contractor for services in making settlement and, in some cases such as Allegany's, the restoration of the contractor's plant to the same general conditions existing prior to the beginning of the work.

Purchasing was discontinued, and hold orders were issued during the negotiation period. As soon as notification of termination was received, subcontractors were notified that all orders were canceled and were asked for a statement of the charges. The only purchases made thereafter were for the necessities required to complete the termination. In all cases where a cancellation charge was involved, subcontractors were asked to furnish a breakdown as to direct labor, direct materials, indirect factory expenses, administrative expenses, subcontractors' claims, scrap credit, engineering expense, and all the other items affecting the cost. They were advised to preserve all papers and pertinent records, since charges would be subject to an audit by Government auditors. They were also advised to hold all supplies and material related to the purchase order as inspection would be made by Government inspectors. Some of the equipment was at such a stage that a fair settlement was arrived at by taking part of the order at full price and a no-cancellation charge on the remainder; however, this is only satisfactory provided use can be found for the material accepted. On other purchase orders, where equipment was being processed along with that for purchase orders from other prime contractors, much difficulty was experienced in determining a just charge.

THERE are two rates of cessation of manufacturing operations, sharp or gradual, and which is used depends on the amount of time between official notification and the date of termination, and the local economic picture. Each method has certain definite advantages and disadvantages to the Government, the contractor, labor, and the community; however, these vary depending on the aims of each party concerned. Since sufficient time was given between notification and date of termination to investigate and work out most of the problems involved, Allegany decided to manufacture to the last minute, then terminate operation sharply since this appeared to offer the better solution. The plant was on a 3-shift, 6-day-a-week basis, and in six days it went from normal production to zero. The third and second shifts left on consecutive days, and the first shift left in part on each of the following four days, as the production line was cleaned up. At the end of ten days, the last round had been inspected and packed and was ready for shipment.

As soon as the notification of termination was received, letters explaining the reason for the reconversion were issued to the employees by both the contractor and the Ordnance Department. At the same time, the Manpower Commission and the U. S. Employment Service were contacted and advised of the tentative schedule of furloughing; thus, they were able to provide for orderly disposition of the labor and also to take care of the unemployment compensation which resulted in some instances. The termination of productive employees coincided with the cessation of operation, and, during the 6-day period, approximately 3,000 or 60 per cent of the employees were separated. Employees other than productive were furloughed in accordance with the cessation of work in their respective departments. As soon as the employees were notified of the termination, a decided change in attitude toward their work caused a loss in efficiency and an increase in accidents. However, as prospects of transfer to the tire company and offers from industries in Baltimore and Hagerstown, Md., began to be heard, morale improved, although it still required much more supervision than normal to get the work out satisfactorily. A month after the termination, approximately sixty per cent of the separated personnel had obtained reëmployment.

The accountability and disposition of Government property offers many a headache, but Allegany was fortunate in that the Kelly-Springfield Engineering Company had excellent records and control of the property. Besides being recorded on a permanent stock-record card, all nonexpendable property was listed by a tabulating machine; thus, it required only a few minutes' time to get a breakdown list of this equipment. Stock rooms and stock-room records were closely controlled, and by a careful procedure of clearing all employees before termination the expendable property was accounted for readily. With respect to the real property, this was returned to the area Engineers for their disposition with the recommendation that in the case where the property was on the contractor's site it be sold to the contractor, provided a satisfactory agreement could be reached. The industrial and miscellaneous property was disposed of in four ways: The greater part was transferred for use at other Government agencies; some was sold; a part was stored as spares or for later sale; and the remainder was scrapped.

Compensation for services in making settlement and restoration of the contractor's plant to approximately the original condition is an involved problem. This is being negotiated at this writing, and it is hoped it can be handled on a lump-sum basis since it is the aim of the Government to make all reconversion with maximum efficiency in time and labor and minimum cost in money and trouble. In this way the Ordnance Department is able to leave after its property has been accounted for and removed, thus allowing the contractor to restore his plant to normal without checking, inspecting, and auditing every step.

The community was somewhat affected by the termination of employment of approximately twenty per cent of its workers; nevertheless, since its annual pay roll was still larger than ever before in its history, the shock from reconversion of one of its major industries was readily absorbed.

In its brief life the Allegany Ordnance Plant produced millions of rounds of ammunition, completing about thirty per cent of its contract. Even though the contract was only partially completed, the ammunition produced cost much less than if it were purchased directly from a commercial concern; in fact, the saving was enough to pay for all the real estate and construction involved in the operation.

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EDITOR'S NOTE.—Under Secretary of War, Robert P. Patterson, writing on the termination of war contracts in the November 15, 1943, issue of the Army Ordnance Bulletin (No. 37), made the following statement: "The War Department is convinced that the settlements must be made *by negotiation* by the procurement agencies and must be final and not subject to reopening by any other agency except for fraud or illegality. The procurement agencies alone have the intimate familiarity with the questions involved which is needed to achieve final settlements promptly."

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JANUARY-FEBRUARY, 1944

## Month by Month

**War Production.**—The following excerpts from the report of President Roosevelt to the Congress on September 17, 1943, give an excellent picture of the status of America's war production since May 1940. Despite difficulties and setbacks, this record should be a source of justifiable pride to the men and women of industry—both management and labor—who poured out this vast flood of munitions to our own victoriously fighting troops and those of the United Nations. Reporting on this effort, the President said:

"Our great production program started during the darkest days of 1940. With the magnificent contribution made by American industry and American labor, it is approaching full production. Britain has already attained full production. Today, the British Empire and the United States together are turning out so much of every essential of war that we have definite superiority over Germany and Japan which is growing with every succeeding minute. But we have no minutes to lose. A few facts will show how vast an enterprise this war has been—and how we are constantly increasing the tempo of our production.

"The total amount spent on the war from May 1940 to date is $128,123,000,000. The bill is now running at the rate of $250,000,000 per day.

"Up to September 1, 1943, among the more important items produced and delivered since the armament program started in May 1940, are the following: Airplanes, 123,000; airplane engines, 349,000; tanks, 53,000; artillery weapons, 93,000; small arms (rifles, carbines, machine guns, etc.), 9,500,000; small-arms ammunition, 25,942,000,000 rounds; trucks, 1,233,000. In most instances, more than half of the above total delivered to date was produced during the first eight months of 1943.

"The number of fighting ships and auxiliaries of all kinds completed since May 1940, is 2,380 and 13,000 landing vessels. In the 2½ years between January 1, 1941, and July 1, 1943, the power plants built for installation in Navy vessels had a horsepower equal to all the horsepower of all hydroelectric plants in the United States in January 1941. The completions of Navy ships during the last six months were equal to completions in the entire year of 1942. We have cut down the time required to build submarines by almost fifty per cent.

"The antiaircraft and double-purpose guns produced by the Navy since the defense program started in May 1940, if fired all together, would throw 4,600 tons of projectiles per minute against the enemy. The output of underwater ordnance (torpedoes, mines, and depth charges) during the first half of 1943 was equal to the total production of 1942. During the month of August 1943, we produced almost as many torpedoes as during all of World War I.

"Any one who has had to build a single factory, tool it up, get the necessary help, set up an assembly line, produce and ship the product, will have some idea of what that amount of production has meant.

"Since the outbreak of war in Europe, we have increased our output of petroleum by 66 per cent. We have stepped up our bituminous-coal production by 40 per cent; chemicals by 300 per cent; iron ore by 125 per cent; hydroelectric power by 79 per cent, and steel by 106 per cent."

**High Lights of the Program.**—The National Association of Manufacturers stated recently that in its first two years of war the United States was building more airplanes than all the rest of the world put together; that shipping tonnage launched in that time was 27,000,000 tons—equal to all the shipping of the United Nations before the war; and that the U. S. Navy has more than 13 times as many vessels in service as it had in 1941, despite sinkings. The following are some high lights of the production program:

*Aircraft.*—An annual rate of 100,000 planes reached in October 1943, with a probable total for the year of 85,000 as against 49,000 in 1942—a climb which is even more impressive when the increased percentage of heavy bombers is considered.

Actual aircraft production through October 1943 totaled about 68,000 planes, the approximate number built each month being as follows: January 5,000; February 5,400; March 6,201; April 6,403; May 7,015; June 7,058; July 7,370; August 7,612; September 7,598; October 8,362. Credit for the October gain—which amounted to 764 planes or 10 per cent over September—was attributed chiefly to increased labor productivity in the airplane industry and to the fact that some models, so far as design changes are concerned, have become stabilized.

The average monthly airframe weight output per employee now approximates 60 pounds compared with 28 pounds in January 1941—an increase of approximately 110 per cent. In an action designed to boost plane production even higher,

OWM Director James F. Byrnes announced the Selective Service is arranging to defer all necessary workers in West Coast airplane plants, including their production subcontractors.

(As an interesting side light, our Army Air Forces destroyed 13,500 enemy planes in the 2 years since Pearl Harbor.)

*Merchant ships.*—The total for 1943 was 19,000,000 dead weight tons, or five times 1939's aggregate.

*Naval construction.*—An increase of 1,200 per cent in two years to more than 26,000 vessels in mid-1943 and a goal ahead of 41,179 by mid-1944.

*Machine tools.*—A total of $1,130,000,000 worth in 1943 on top of the record of $1,317,000,000 turned out in 1942.

*Steel.*—Close to 90,000,000 tons for 1943 against 53,000,000 in 1939.

*Aluminum.*—An estimated 1,841,000,000 pounds in 1943 against 327,000,000 in 1942. The total 1943 supply, including imports and scrap, amounted to approximately 2,846,000,000 pounds against 444,000,000 in 1939.

*Magnesium.*—The output for 1943 was estimated at 336,000,000 pounds against 6,700,000 in 1939, with a goal of 500,000,000 pounds a year by the end of 1944.

*Copper.*—A total 1943 output of 3,078,000 short tons almost doubles the 1939 supply.

*Rubber.*—Synthetic rubber production climbed from about 22,500 tons in 1942 toward 275,000 tons in 1943, with a goal of 850,000 tons for 1944.

*Petroleum.*—Wartime secrecy masks figures on aviation gasoline, but Secretary Ickes said an old goal of 150,000 barrels daily is obsolete against 40,000 daily at the time we entered the war.

**The New 75-mm. Aircraft Cannon.**—Almost on the heels of announcement that the Germans had armed their aircraft with rocket weapons for use against our bomber formations came the startling disclosure that our own North American B-25 Mitchell medium bomber had been equipped with an Ordnance-developed 75-mm. gun capable of comparatively rapid fire (see illustrations on p. 102). This should be more than an answer to the German rocket weapon.

Ordnance officers have dreamed of taking field weapons "upstairs" since the last war. They saw the beginning of that dream's realization more than four years ago when the first demonstration that a high-powered 75-mm. gun could be fired successfully from a plane was given before a group of Air Forces officers at the Aberdeen Proving Ground, Aberdeen, Md. In that first showing of the possibilities of airborne artillery, a pilot model 75 was fired from a B-18 aircraft by Col. Horace A. Quinn, Ordnance Department, then a captain. As in most such radical developments, modifications were found necessary, and a demonstration of an improved model was given in 1940 at Eglin Field, Fla., before the Air Forces Board. The gun recoil and recuperator mechanisms of the "Flying 75's" were turned out at the Ordnance Department's Watervliet and Rock Island Arsenals, sources of gun and artillery development in this country.

Ordnance and Air Forces officers found results of these trials—and many others made at the Ordnance Research Center at Aberdeen—more than encouraging. Under the direction of Col. (now Maj. Gen.) G. M. Barnes, chief of the Ordnance Department's extensive research and development program, a number of industrial concerns were called in to the then-secret program to aid in ironing out manufacturing and further development problems. The result of the coöperative program was a new 75-mm. aircraft gun for the Army Air Forces, together with a recoil mechanism and mount designed to meet the peculiar requirements of aircraft installation.

Working under Colonel Quinn, who tested the original aircraft gun, Victor F. Lucht, an ordnance engineer in the Ordnance Department, designed a new recoil device and perfected technical details that assured flawless operation of the new weapon. After extensive ground trials, the new weapon was tried in the air under the supervision of Ordnance personnel.

Today, the fact that a gun the same size, but of greater power than the field artillery most in use in the World War, can be fired from airplanes with speeds of more than 300 miles an hour staggers the imagination.

According to Maj. Gen. L. H. Campbell, Jr., the air-borne weapon will knock out any tank now known to be in use, sink lightly armored warships, and destroy enemy gun emplacements. "Those Air Forces boys really can aim that gun; I've seen them in practice hit small targets at thousands of yards," he added. Ira Wolfert, North American Newspaper Alliance war correspondent, reporting from the South Pacific area, discussing the gun's accuracy, wrote: "Just before leaving the States, they (the pilot and navigator) had worked over a target 6 feet high and had put 22 shells through it in 25 tries from 2 miles away, going better than 250 miles an hour."

First use of the cannon-firing B-25 was against the Japanese in New Guinea, when it joined in action against a Japanese air transport which was destroyed as it made a landing. Stalking bigger game in the same area, the B-25 was sent against the larger of two Japanese destroyers. Five direct hits were scored and the warship was left in a sinking condition. Action by the heavily armed plane has been extended to include gun emplacements, landing barges, and tanks.

According to North American Aviation, in making changes to accommodate the cannon installation, a new and shorter nose structure was designed for the new B-25 to replace the glass-enclosed bombardier's compartment. It was also necessary to relocate the controls from the forward compartment to the pilot's compartment, revise the navigator's compartment, and install additional armor plate.

The cannon, built on a mount assembly, is located in what was formerly a passageway beneath the left side of the pilot's compartment. The muzzle projects through a blast tube forward in the lower nose section and the breech extends aft to the left forward side of the navigator's compartment. Two fixed caliber .50 machine guns also have been installed in the nose of the bomber. Both the machine guns and the cannon are fired by the pilot who presses a button on the control wheel when he has his target in the sights and in range. Despite the addition of the 75-mm. gun, the B-25 still retains its effectiveness in dropping bombs, strafing troops, and carrying torpedoes, and its bomb-bay capacity or its speed has not been affected.

The Ordnance Department's research and development system is conceded to have enabled the United States to take the lead among the nations of the world in aircraft armament. Among the products of this system are the caliber .50 aircraft machine gun, together with its incendiary and armor-piercing ammunition, and the 37-mm. aircraft cannon.

# Twenty-Five Years

## An Editorial

MARINERS, piloting their ships, have for their assistance aids based upon the experiences of those who have sailed the same seas before. Lights, beacons, buoys, charts, and the omnipresent radio offer a wealth of reliable information to the seafarer to assist him in threading his way safely through tortuous channels.

The situation is quite different where the question is that of piloting craft of state; whether it is a matter involving the very Ship of State itself or a lesser, but possibly still large, one affecting the innumerable smaller craft—the figurative cruisers, tugs, launches, and even rowboats—which are necessary auxiliaries to the Ship of State. There is no way of setting up aids to navigation for new and hitherto untraversed seas into which the mere passage of time continuously forces these craft to sail.

One of those seas, of vital concern to every human being living today or who will live during centuries to come, is that of global warfare. A principal gulf in that sea is that of total national war effort. Certainly no realistic person, after the experience of World War I, will credit the claim that World War II is the war that will end all wars. However devoutly one may wish for that consummation, he must realize that our surest guarantee of peace will continue to lie in our own capacity for protecting our national interests against the Hitlers and Hirohitos to come.

When Congress, after the termination of World War II, proceeds to make necessary changes in the statutes which provide for our national defense, it will have to enter uncharted seas. It must project as best it can into the unknown future the lessons of the recent past in the endeavor to afford our country proper security against contingencies to come. There will be two clearly defined aspects to the problem: First, *the military phase* (including under this term our armed forces of all categories) which involves preparing for the organization and use in time of emergency of the military man power of the Nation armed and supplied with munitions as adequately as circumstances permit. Secondly, there is *the industrial phase,* which involves preparing for the most effective use in the defense effort of all available nonmilitary man power and of all available material resources.

It is important to observe that the industrial effort must include not alone the supply of munitions to our armed forces but must also embrace the maintenance of the whole civilian economy of the country. The man behind the man behind the gun is no less essential than the gunner himself. The industrial phase is far more difficult of approach than is the military one. Military organization and operations—strategy, tactics, and logistics—have evolved through thousands of years. There is a vast amount of literature available for the study of past experience; training systems have been evolved and are under continuous development in peace as well as in war; a school system is in being, culminating, for the Army, in the Command and General Staff School and the Army War College and, for the Navy, in the Naval War College. A Joint Army and Navy Staff College also has recently been established.

There is no similar age-long background for the industrial phase. Global warfare, from the industrial point of view, did not emerge until World War I was thrust upon civilization by Teutonic ruthlessness. Under the stress of war necessity, a gradual evolution of the industrial effort on the home front took place. In this country, the Chamber of Commerce of the United States formed its Committee on National Defense in 1915. The Council of National Defense, consisting of cabinet members only, was formed by Act of Congress in 1916. It soon acquired an advisory commission of industrial leaders. In April 1917, the General Munitions Board was set up by the Council of National Defense and in turn was succeeded in July 1917 by the War Industries Board. Similarly, other organizations were evolved to handle other phases of the internal economy of the country, such as the Food Administration, the Fuel Administration, and the Railroad Administration.

THE evolutionary aspect of the industrial phase of our war effort during World War I is well illustrated by the fact that it was not until March 4, 1918, that the War Industries Board acquired the authority which was essential to its proper functioning. It is worth-while to digress at this point to quote the Executive order which really put teeth into the authority of this Board as a classic example of the essential necessity for the delegation of authority and centralization of responsibility if operational results are to be secured:

> "The Board should be constituted as at present and should retain, so far as necessary and so far as consistent with the character and purpose of the reorganization, its present advisory agencies; *but the ultimate decision of all questions, except the determination of prices, should rest always with the chairman, the other members acting in a coöperating and advisory capacity"* (italics supplied).

Apparently, President Wilson had come to an appreciation that in the higher echelons of organization, committee and conference operation lead to hopeless confusion and endless delay. Possibly he had in mind in his delegation of authority to Mr. Baruch the precept in handling subordinates in higher echelons of organization: "Back 'em or bust 'em." (The military has recognized this for many centuries. It is likewise well known to industrial leaders and to some governmental bureaus. Perhaps it will ultimately become generally known!) With consummate skill and with a velvet glove on his iron hand, but with an iron hand nevertheless, Mr. Baruch piloted the War Industries Board until the war was over. It constitutes an outstanding example of a simple solution of a most difficult problem of industrial organization. It depended upon the delegation of Presidential authority. It could not have functioned under lesser authority.

Concurrent with the evolution of the superorganizations, each operating under delegation of Presidential authority, evolution was also taking place in the War Department. A clear demarcation with excellent coöperation was maintained between the military phase under the Chief of Staff and the industrial phase under the Assistant Secretary of War. *An outstanding development of the industrial phase was the decentralization of procurement through the organization of the district system.* This originated in the Ordnance Department, probably because the officers of that Department, under

the policy of Maj. Gen. William Crozier (Chief of Ordnance, 1901-1918), had had shop training and actual manufacturing experience at arsenals and therefore understood the necessities of industrial operation. Moreover, and most important, Maj. Gen. C. C. Williams, who succeeded General Crozier in 1918, had secured the assistance of several leaders of American industry in setting up the organization of his office and putting into operation the Ordnance district system.

Congress, in the National Defense Act of 1920, recognizing the experience of World War I, wrote into the statutes the demarcation between the military and the industrial phase. The former was placed under the Chief of Staff and the latter under the Assistant Secretary of War. The Assistant Secretary of War set up the Army Industrial College to do for the industrial phase what the Army War College was doing for the military. He caused the district system to be extended to all supply branches. This was the setup which was in effect at the outbreak of World War II. To it more than to any other single factor must be given credit for the success which has been achieved in securing the production of an adequate supply of munitions in this conflict.

THE Army Ordnance Association was organized in 1919 "to assist in effecting industrial preparedness for war as being one of the Nation's strongest guaranties of peace." It has consistently adhered to this aim throughout its nearly twenty-five years of existence. It has backed every effort of successive Chiefs of Ordnance in their work in the districts and elsewhere, and every Chief of Ordnance since the formation of the society in 1919 has testified to its effectiveness to this end.

The flow of munitions from the factories to the troops is one of the epics of World War II. In terms of dollars and of tonnage, the largest percentage of the munitions is "ordnance." Ordnance is characterized as being for the greater part "special" and its production has required enormous plant capacity. Cornfields have been converted into tank arsenals; pasture lands into ammunition factories. The conversion of huge existing plants manufacturing commercial articles into war plants has frequently, if not usually, meant the use for war purposes chiefly of the building itself and of its cadre of organized and trained personnel. Indeed "creation" is a better term than "conversion" for the greater part of the plants in which American industry has produced ordnance.

Primarily, of course, credit is due to industry itself for the wholehearted way in which it turned from its normal civilian activities to work assigned it in order to promote the war effort. But industry had to be told what to do. To three factors must go the chief credit for making it possible for industry to function as it has. These are: (1) The Army Industrial College which trained and indoctrinated a large number of Army and Navy officers—both Regular and Reserve—and civilian industrialists in the over-all aspects of the industrial phase; (2) the Ordnance district system which, under the direction of the several chiefs of the supply services, decentralized procurement into the hands of industrialists who were given a general idea in time of peace of how the system would function in time of war; and (3) the coöperation of American industry through the years of peace in the work of industrial preparedness.

It cannot be claimed that our industrial war planning was complete or without error. In the searching light of hindsight doubtless much could be criticized and many errors and insufficiencies pointed out, even considering the very limited appropriations available for the purpose. (Something on the order of only two per cent of the funds annually appropriated for the Army during the period 1920-1938 were available for *all* the needs of the Ordnance Department. These included current supply and maintenance, the upkeep of the arsenals, and research and development as well as industrial preparedness.) But it is fair to claim that the degree of industrial preparedness actually achieved has saved the country untold millions of dollars in terms of the money cost of munitions, and, important beyond words, the rapidity with which the production of munitions has been established has saved and will save tens of thousands of the lives of our American youths on the field of battle.

PROBABLY nothing will be more important for the future peace and security of our country than adequate provision for industrial preparedness in the approaching postwar era. Obviously, any future would-be aggressor will study the lessons of World Wars I and II. He will see there the failures due to not following up the gas attack at Ypres in April 1915; to the premature exploitation of the tanks at Thiepval in September 1916; to the lack of German aggression after Dunkerque in 1940. He will note the effect of the rubber and quinine situations in 1941-1944. He will realize the transient supermilitary value of new developments such as the Bazooka between the period of its first appearance and the development of means and tactics to meet it. Above all, he will note that if the democracies of the world are to be beaten it will necessarily be done before they can develop their potentialities for the production of munitions and their use in combat. In short, the next Hitler will certainly try to develop his military power to the utmost in the greatest secrecy he can attain, and he will start hostilities with another Pearl Harbor.

The inescapable moral is *that the democracies must keep themselves prepared* to meet and subdue aggression exactly as fire departments keep themselves ready to meet and subdue conflagrations. The parallel, of course, fails in exactness: fires ordinarily occur without reference to the preparations which have been made to meet them; international bullies are great respecters of the might of other nations.

As it enters its twenty-fifth year, the Army Ordnance Association will endeavor in the future, as it has in the past, to keep alive an interest in and knowledge of the design, production, and maintenance of ordnance. The principal objective of the Association will remain, as always, an active membership of American citizens to assist in the design, development, procurement, production, maintenance, and supply of the weapons of defense to the fighting forces of the United States. When peace returns, this body of informed citizens will again continue to be a bulwark of knowledge and experience upon whom the armed forces of our country can rely for technical and scientific assistance. Also, in the future as in the past, the Association will remain aloof from political and commercial interests.

The above is but a brief retrospect of the work with which the Army Ordnance Association is proud to have been associated during the past twenty-five years and a slight preview of what is ahead. The Association faces the future with the belief that the coöperation of American industry will be needed by the Government in the work of preparedness even more in the years to come than in the past and with the confident assurance that industry will give that coöperation in unstinted measure. While trusting in God, we will keep our powder dry.

R. H. S.

# Association Affairs

### Annual Meeting—Twenty-Fifth Year

THE Army Ordnance Association will celebrate its twenty-fifth anniversary at the Waldorf-Astoria, New York City, on Wednesday, January 19th, when its Annual Meeting will be held. The program will feature Round Table discussions of Ordnance progress by military and industrial leaders, an exhibit of ordnance matériel, and the Annual Dinner and General Session at which the Association's honors for distinguished ordnance service will be presented.

At the Round Table conferences, analyses will be presented on the four principal divisions of Ordnance activity, followed by question-and-answer periods. From 2:30 to 4:00 P.M., Round Tables will be held on "Ordnance Production," in the Astor Gallery, with Maj. Gen. Thomas J. Hayes, chief of the Ordnance Industrial Division, presiding; and on "Ordnance Field Service," in the Jade Room, with Brig. Gen. Julian S. Hatcher, chief of the Ordnance Field Service Division, presiding.

From 4:30 to 6:00 P.M., conferences will be held on "Ordnance Engineering," in the Jade Room, with Maj. Gen. Gladeon M. Barnes, chief of the Ordnance Technical Division, presiding; and on "Ordnance Training," in the Astor Gallery, with Brig. Gen. Harry R. Kutz, chief of the Ordnance Military Training Division, presiding.

The exhibit of Ordnance matériel will be arranged by Maj. Gen. C. T. Harris, Jr., Commanding General, Aberdeen Proving Ground. The exhibit will be on display in the East Foyer of the Waldorf-Astoria during the day.

The Annual Dinner will be held in the Grand Ball Room at 7:00 P.M., with Brig. Gen. Benedict Crowell, president of the Army Ordnance Association, presiding, and Reginald E. Gillmor, president of the New York Post, as toastmaster. At the General Session following the dinner, the Crozier Gold Medal will be presented to Maj. Gen. L. H. Campbell, Jr., Chief of Ordnance of the U. S. Army; the Scott Gold Medal to Rear Adm. W. H. P. Blandy, Chief of the Bureau of Ordnance, U. S. Navy; and the Rice Gold Medal to Tom M. Girdler, chairman of the Association's Committee on Endowment.

The principal address will be given by Charles E. Wilson, Executive Vice-Chairman of the War Production Board.

Because of present conditions, members are limited to one guest at dinner, and special seating arrangements cannot be made. Seating will be assigned in the order of receipt of reservations, forms for which were mailed to all members on December 20th. Reservations will close on January 14th, and no tickets will be sold and no cancellations accepted after that date. Business dress will be worn at the dinner.

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### St. Louis Post

ORDNANCE contractors and members of the Army Ordnance Association in the St. Louis Ordnance District attended a meeting of the Post at the Scottish Rite Cathedral in St. Louis, Mo., on December 20th. Joseph M. Dodge, chairman of the War Department Price Adjustment Board, was the principal speaker and discussed the philosophy and current principles of administration of the renegotiation statute.

Russell E. Gardner, Jr., deputy chief of the St. Louis Ordnance District, also spoke on the current efforts of the Ordnance Department to make, by renegotiation, fair and rapid settlement of terminated Ordnance contracts.

The addresses were followed by presentation of a humorous playlet "Negotiation for Terminations" or "You Can't Take It with You," staged by personnel of the St. Louis Ordnance District. This skit has also been successfully produced in various other sections.

Edwin B. Meissner, is president of the St. Louis Post of the Association.

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### Cincinnati Post

AN ambitious dinner conference which had as its theme "The Termination of War Contracts," was sponsored by the Cincinnati Ordnance District and the Cincinnati Post of the Association at the Netherland Plaza Hotel in Cincinnati on October 29th. Col. Fred A. McMahon, chief of the Cincinnati District and secretary of the local Post, was toastmaster.

Principal speakers were Col. Cassius M. Dowell—senior defense counsel of the eight German saboteurs tried before a military commission in Washington, D. C., in 1942—who spoke on "Trials by Military Commissions," and Col. J. C. Shouvlin, deputy chief of the Cincinnati District, who spoke on "Termination of War Contracts." A humorous playlet, "An Ex-Termination," or "Ruin to Recovery—in Three Acts," was presented by Cincinnati Ordnance District personnel including Maj. F. A. Christoffer, Capt. G. J. Matesich, Lieut. John M. Kitchen, Lieut. H. F. Pine, and Messrs. H. Borneman, J. B. Sparling, and H. A. Pendergraph. More than 700 persons attended the affair, and several hundred reservations had to be returned. Harvey C. Knowles is president of the Post.

The program opened with dinner at the Netherland Plaza. Immediately thereafter, Colonel McMahon called the business portion of the meeting to order.

"This meeting is held," Colonel McMahon said, "for the express purpose of explaining to you just what steps you must take after you have received word that your contract is terminated. We are prepared to work fast, if you will do your part. We are just as anxious as you are to help you shift over from work on contracts for items that are of no further use, to work on contracts for items that are critical. Later on, you will be anxious to get out of the war business and get rid of the machine tools, materials, and equipment you no longer need so that you can return to your commercial business with the utmost dispatch. We want to help you do this, too, and as fast as possible."

In his address, Colonel Shouvlin said: "We are not having this gathering because the war is over. This country faces hard fighting, hardships in our normal lives, and many adjustments in the supply program before the war is over. Terminations arising from improved designs and changing requirements are and will be a tremendous job. It cannot be done by Ordnance alone; it requires your help and coöperation—with the same coördination with which the Ordnance-Industry team has functioned so well on all its problems.

"You can see sample items on display here which are representative of the many items of Ordnance design. You can also see some charts indicating the progress of the district in the successful drive for more efficient and economical operation. Those items on display were developed because of the fluidity of war—requiring improved matériel based on actual field conditions which require our troops to be equipped with firepower superior to that possessed by our enemies. That is the reason for terminations now. As these new weapons proved themselves in combat, contracts for the weapons obsoleted have been terminated. Obsolescence and improvements required by the acid test of battle are the basic causes of terminations and readjustments of requirements during the war.

"The Cincinnati Ordnance District is organized to work quickly. Our pace will be determined by the speed with which your claims are filed. Organize properly; know your procedures; join with us in making our goal a speedy, satisfactory, and just settlement of all our claims. Do it right—and do it right away."

In order to supplement the various points brought out by

# MEMBERSHIP
## in the
# ARMY ORDNANCE ASSOCIATION

**A MEMBERSHIP SOCIETY OF AMERICAN CITIZENS DEDICATED TO VICTORY THROUGH ARMAMENT RESEARCH, PRODUCTION, AND LOGISTICS**

The Association was founded in 1919 to foster an understanding of industry's rôle in our national defense among scientists, engineers, inventors, manufacturers, and other interested Americans, both civilian and military. Its sole purpose is to keep available the highly specialized knowledge necessary for arming the Nation's manhood by stimulating interest in the design, production and maintenance of our weapons of defense. The Association, a membership organization without subsidy of any kind, is carrying on this patriotic work through its national and local conferences; its bimonthly journal, ARMY ORDNANCE; and its monthly news Bulletin of timely industrial-military information.

### ELIGIBILITY

The following men are eligible for individual membership: 1. All civilian engineers, scientists, manufacturers and executives of American industry. 2. All members of the military and naval forces of the United States—Regular, Reserve and National Guard. 3. All others interested in our national defense. American citizenship is a requirement of membership. Dues: Four dollars annually. There is no initiation fee and no other obligation.

# APPLICATION FOR MEMBERSHIP

THE ARMY ORDNANCE ASSOCIATION,
MILLS BUILDING, PENNSYLVANIA AVE. AT 17TH ST.,
WASHINGTON 6, D. C.

I hereby apply for individual membership in The Army Ordnance Association and enclose annual dues ($4.00) which include ARMY ORDNANCE and all other membership privileges for one year from date of admission. The following statements are true to the best of my knowledge and belief:

Name.....
*(Print plainly)*

Address.....
*(Street and Number)*

.....
*(City and State)*

I am a citizen of.....

Color (race).....

Born at.....Date.....

Educated at.....

Courses.....

Present civil position.....

Previous civil experience.....

.....

Military or naval service (if any).....

.....

If not now in service, was discharge honorable?.....

Present military or naval status.....

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References (not necessarily members of the Association).....

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Date.....

Signature.....

*(Do not write below this line)*

Application received.....

Elected to membership.....

the playlet, Lieut. Col. F. W. Smith, contracting officer in charge of purchasing and purchase policy, spoke briefly. "It is hoped," said Colonel Smith, "that the play and the other portions of this program will develop with our contractors a better understanding of the policies and procedures of the Cincinnati Ordnance District in the termination of contracts, as in the case portrayed, for the convenience of the Government. Policy and procedure of terminations for the Army, based on the authority contained in public laws, is regulated by procurement regulations issued by the Army Service Forces.

"We expect to give you fair and just treatment. The district prides itself on the record of accomplishment and honesty which the contractors of this district have won for themselves in their dealings with the Government. The district wants you to know that in making that record, great reliance has been placed on the representatives of the contractors."

Many questions from contractors had been submitted to the termination section previous to an earlier meeting. Based on these, three representatives of the Cincinnati Ordnance District spoke briefly on their special subjects. Emphasizing the need for prompt action, Capt. G. J. Matesich, chief of the termination section, took as his subject "The Prime Contractor and the Termination."

"If the termination will result in your filing a claim," said Captain Matesich, "it is necessary that you immediately plan your work to assemble the information required for the proper preparation and filing of your claim. Proper planning on your part will permit you to take care of *all* the important things you have to do, including prompt action on your termination."

Captain Matesich further covered the filing of subcontractors' claims and how they are handled. He also covered various items which may, in accordance with generally accepted principles of accounting, be included in claims. Inventories and their disposition, partial payments on account, verification and certification were also covered.

Discussing the subject of "The Termination of Subcontractors," Lieutenant Kitchen said: "Termination of subcontractors affects most of our American production facilities and most of our production workers. So it behooves all subcontractor representatives, as well as their prime contractors, to understand what happens when termination of subcontracts comes about." He continued by explaining the application of legal rules, the relationship between prime and subcontractors, partial payments to subcontractors either through the prime or direct, the application of certain fact situations to reduce subcontractor claims, necessary certifications, and disposition of excess materials.

The last speaker, Maj. G. E. Fee, chief of the Legal Branch, touched on the subject of "Some Legal Phases of Terminations." Any clear understanding of Government procedures in connection with termination of war contracts, he said, must be founded on a knowledge of the terms of the standard clause providing for termination at the convenience of the Government. A Government contractor whose contract has been terminated does not come before the contracting officer as a supplicant seeking favor. Rather the contractor appears as a claimant demanding full measure of his legal rights, Major Fee said.

Colonel McMahon then brought the formal part of the meeting to a close, stating that the three officers who had just spoken would be glad to remain as long as any one had any questions. Contractors' representatives were invited to ply them with any questions which arose in their minds, and approximately seventy-five individuals remained for an hour and a half after the conclusion of the meeting to ask questions.

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### DETROIT POST

THE fall dinner meeting of the Detroit Post of the Association was held at the Book-Cadillac Hotel, Detroit, on October 27th, with Maj. Gen. Levin H. Campbell, Jr., Chief of Ordnance, as guest of honor and principal speaker. Col. Herbert W. Alden, president of the Detroit Post, presided at the business session which followed the dinner. During this period, the new constitution and by-laws of the Post were officially adopted by the membership.

K. T. Keller, president of Chrysler Corporation and a member of General Campbell's Advisory Committee, was toastmaster at the dinner. In a brief address, Mr. Keller demanded that industry be given a voice in planning new ordnance production programs and urged the Detroit Post of the Association to become the strongest local chapter in the country in order to make its voice heard in the postwar period. Col. L. A. Codd, executive assistant to the Chief of Ordnance and former editor of ARMY ORDNANCE, also spoke.

General Campbell's address on "Ordnance Firepower in Battle," is published in full on p. 69 of this issue. Others at the speakers' table included:

Brig. Gen. A. B. Quinton, Jr., Detroit Ordnance District; O. E. Hunt, General Motors Corporation; Maj. Gen. A. W. C. Richardson, British War Office; Brig. Gen. J. K. Christmas, Detroit Tank-Automotive Center; Edward G. Budd, Budd Manufacturing Company; Brig. Gen. H. R. Kutz, chief, Ordnance Military Training Division; Robert L. Biggers, president, Fargo Division, Chrysler Corporation; Col. Ray M. Hare, Fort Wayne Ordnance Depot; J. L. McInerney, McInerney Spring & Wire Company; L. A. Young, L. A. Young Spring & Wire Company; I. K. Stone, Duplex Printing Press Company; S. Perry Williams, Kelsey-Hayes Wheel Company; Charles O. Chestnut, McCord Radiator & Manufacturing Company; Warren H. Farr, Budd Wheel Company; Stephen T. Stackpole, Pennsylvania Railroad Company; H. L. Pierson, Detroit Harvester Company; Col. J. L. Walsh, vice-president, Army Ordnance Association; Brig. Gen. W. P. Boatwright, Commanding Officer, Detroit Tank-Automotive Center; Edward T. Gushée, Detroit Edison Company; Oliver Lucas, chairman, Lucas Mission, British Ministry of Supply; Brig. Gen. S. E. Reimel, Detroit Tank-Automotive Center; Brig. Gen. R. H. Somers, secretary, Army Ordnance Association; Oscar Webber, J. L. Hudson Company; Chas. T. Bush, Chas. A. Strelinger Company; W. G. Lerchen, Watling, Lerchen & Company; H. E. Hund, Reo Motors Corporation; Phil Huber, Ex-Cell-O Corporation; Carl B. Parsons, Parsons Company; W. G. Lewellen, General Motors Corporation; Capt. J. W. Paynter, secretary, Detroit Post Army Ordnance Association.

A number of ordnance weapons, including the Bazooka rocket launcher, were on display in the Book-Cadillac in connection with the meeting.

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### ROCHESTER POST

THE annual dinner-meeting of the Rochester Post was held at the Oak Hill Country Club in Rochester on October 25th. Brig. Gen. Julian S. Hatcher, chief of the Ordnance Field Service Division, was the guest of honor and principal speaker.

Frank J. Smith, president of the Rochester Post, presided and introduced the Hon. Samuel B. Dicker, mayor of Rochester, who welcomed visiting members and guests to the gathering. Erwin R. Davenport, chairman of the Rochester Ordnance District Advisory Board and treasurer of the Rochester Post, also spoke, reporting, among other things, good results from an active membership campaign now under way.

Col. Frank J. Atwood, chief of the Rochester Ordnance District and secretary of the Rochester Post, in introducing General Hatcher, spoke in part as follows:

"The storage, issue, repair, and maintenance of ordnance matériel are all functions of the Ordnance Field Service Division. The chief of that division will tell you about its operations. This distinguished officer graduated from the United States Naval Academy in 1909. He served fourteen months as a naval officer when he resigned to become a second lieutenant in the Army's

Coast Artillery Corps. Since that time his career has been most distinguished. He is one of the Nation's foremost small-arm's experts and is the author of several textbooks on small arms. In 1931, he won the Webley and Scott Pistol Match at Bisley, England, with a perfect score—which has never been equaled. He is the inventor of a breech mechanism for cannon which was adopted for use by the Army. . . .

"Since the first World War he has had charge of rifle manufacture at Springfield Armory and of cartridge manufacture at Frankford Arsenal. He also served at Watervliet and Watertown Arsenals. He has served as commandant of the Ordnance School, as commanding general of the Ordnance Training Center, Aberdeen Proving Ground, and as chief of the Ordnance Military Training Division. Now he is chief of the Ordnance Field Service Division. As General Campbell has aptly said, 'Ordnance in Battle' is the watchword these days. Our speaker is your country's best-equipped man to tell you about this most important phase of our global war."

General Hatcher's remarks are published in full on page 77 of this issue.

More than 350 members and guests attended the meeting, including members from Albany, Oswego, Utica, Syracuse, Jamestown, Elmira, Ithaca, Binghamton, and Buffalo, N. Y. Plans are being arranged for a meeting of the Post in Buffalo in January.

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### TEXAS POST

THE annual meeting of the Texas Post was held at the Adolphus Hotel, Dallas, Tex., on October 22nd. The meeting began with a general "Fellowship Hour" at 6:00 P.M., and was followed by a dinner at 7:00 P.M. A short business session was held following the dinner at which time the results of the election of officers for the ensuing year were announced and the officers duly installed. The following officers and directors were elected by mail ballot in accordance with the constitution of the Texas Post: B. T. McNeil, Houston, president; William R. England, Houston, vice-president; Harry Sinclair, Houston; J. N. Kincaid, San Antonio; and Lieut. Col. Colin McRae, Dallas, directors to serve for two years.

After the business session, a 3-act playlet entitled "Negotiation for Terminations" or "You Can't Take It with You" was staged by the Murray Dramatic Club. This play was originally written by members of the Chicago Ordnance District office, and while it was definitely a comedy and produced many ridiculous situations and remarks, it brought out quite forcefully certain points with which contractors will be faced on the occasion of termination of Ordnance contracts.

Col. Merle H. Davis, chief of the St. Louis Ordnance District, then addressed the meeting on "The Business Side of Our Ordnance Contracts." In his address, Colonel Davis pointed out many of the unknown factors and uncertainties which face the Ordnance contractors, and cited numerous examples demonstrating the methods used by the Ordnance Department to maintain the manufacturer's financial solvency and give him as much relief as possible during the period of transition from one contract to another or at the termination of his Ordnance contract.

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### NEW YORK UNIVERSITY POST

AT a recently held election of officers of the New York University Post of the Association, Thomas R. Torian was reëlected to the office of president, Elliot Schick was named vice-president, Robert F. Borg, treasurer, and Stanford Schwartz, secretary.

Herman Shaub, civilian administrator of the New York Ordnance District Gage Laboratory, was the guest speaker at a smoker held by the Post in November. Mr. Shaub spoke on the inspection of tools and instruments and inspection methods.

### GENERAL MAXWELL HONORED

MAJ. GEN. RUSSELL L. MAXWELL, now Ordnance Officer, G-4 War Department General Staff, formerly commander of the Army Service Forces Unit Training Center, Camp Ellis, Ill., and former commander of the American Forces in the Middle East, has been made an Honorary Companion of the Military Division of The Order of the Bath by the British Government. General Maxwell has long been a member of the Association and was editor of ARMY ORDNANCE during 1925-1926. The following citation accompanied the award of the honor:

"In his capacity as Commanding General, United States Forces in the Middle East, General Maxwell rendered signal services to the allied cause. Later, as Commanding General, Service and Supply, he continued to perform with great ability services to the British Army in the Middle East which were of outstanding importance and of the very greatest assistance to our military efforts.

"General Maxwell at all times, and in face of every difficulty, showed a willing determination to promote by every means in his power the development of satisfactory relations between the British forces and the forces of the United States. By his willing coöperation and ready help he materially assisted in all questions of supply to the British forces and the forces of the United States. The organization set up under his direction and control in the Middle East played a very prominent part in the maintenance and repair of military equipment supplied by the United States for the use of our forces and thereby aided materially the victorious operations of the Eighth Army.

"His assistance in connection with the provision of units and material for the development of the Trans-Persian Railway and the ports of the Persian Gulf were not only of great advantage to the British forces employed in that area but in no small measure helped the allied cause as a whole by furthering 'Aid to Russia' through those channels of supply."

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### ORDNANCE OFFICERS RECEIVE LEGION OF MERIT

A number of Ordnance officers, both commissioned and noncommissioned, have been honored by the award of the Legion of Merit for exceptionally meritorious conduct in the performance of outstanding service.

*Maj. Gen. C. C. Williams,* of South Hamilton, Mass., who was Chief of Ordnance of the U. S. Army from July 1918 to April 1930, was awarded the Legion of Merit during a special ceremony at the First Service Command headquarters. The award was presented by Maj. Gen. Sherman Miles, Commanding General of the First Service Command in the presence of high-ranking Army officers from that area. General Williams, a charter member of the Army Ordnance Association, was graduated from West Point in 1894 and retired from active duty on April 1, 1930. He was recalled to duty on January 15, 1942. The following citation accompanied the award:

"As War Department member of the National Defense Research Committee and liaison officer for the War Department with that committee during the period March 31, 1942, to July 7, 1943, General Williams, by his outstanding technical and professional ability, tact, and good judgment, was successful in solving the many difficult problems of coördination and conflict of interest that arose in connection with relating the responsibilities of the War Department technical services with those of the National Defense Research Committee."

*Maj. Gen. James K. Crain,* of San Antonio, Tex., was chief of the Ordnance Field Service Division from April 1, 1940, to June 5, 1942, and "by his leadership, judgment, and high professional attainments, rendered exceptionally meritorious service during the period of the declared National Emergency and present war. He amalgamated and expanded the military and civilian elements of the Field Service Division throughout the United States into a smoothly operating organization, providing

adequate expansion of storage, depot, and maintenance facilities to support the expanding Army of the United States . . . General Crain's services in the exercise of this important duty have made a material contribution to the development of the fighting Army of the United States."

*1st Lieut. (then Mstr. Sgt.) Thomas O. Murphy*, of Atkinson, N. C., organized, set up, and directed the operation of medium-maintenance shops, carrying on maintenance work in the open during the arctic winter. "His tireless devotion to duty," the citation reads, "necessitated long and irregular hours and contributed immeasurably toward the combat efficiency of the force."

*Mstr. Sgt. Arto C. Monaco*, of Upper Jay, N. Y., developed visual aids for use in the training program of the Ordnance Department. "His creative imagination, high degree of technical skill, and ability to organize and inspire others produced the many excellent visual aids which are used in all phases of instruction in this establishment and greatly facilitated the execution of the training program."

*Tech. Sgt. Lewis H. Zerbe*, Mohnton, Pa., was an instructor in small-arms repair to the cadre of the Quartermaster Replacement Training Center, Camp Lee, Va., from June 17, 1942, to March 31, 1943, where he conceived the idea of training a representative number of the Quartermaster Replacement Training Center as company ordnance mechanics. "The conception of the idea was excellent, and Technical Sergeant Zerbe has displayed skillful ability in organizing his instruction and transmitting his knowledge to his classes. His methods of instruction have become standard for his assistants and his ability and perception have succeeded in quickly training company mechanics in the repair and maintenance of small arms. The results thus obtained have kept a maximum number of weapons at Camp Lee in service."

*Staff Sgt. Andrew Lossky*, of New Haven, Conn., was in charge of a subsection in the G-2 section of a corps headquarters in North Africa and Sicily from January to August 1943, in which assignment he fulfilled the duties normally assigned to an officer. "He brought to this assignment exceptional scholarship and a knowledge of five foreign languages. These talents were applied with unflagging zeal and painstaking research, with the result that information on Italian and German forces opposing the corps throughout the Tunisian and Sicilian campaigns was accurate and comprehensive. He exercised great discrimination in his studies, and the information which he compiled from them was a major contribution to the success of both campaigns."

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### COLONEL HODGES PROMOTED

LIEUT. COL. LeROY HODGES, formerly Comptroller of the State of Virginia and a former national director of the Army Ordnance Association, has been promoted to the rank of colonel and assigned as Ordnance Officer with the headquarters of the Virginia Protective Force (State Guard). Colonel Hodges was Ordnance Officer of the former Virginia National Guard and is the author of "Postwar Ordnance." When on active duty in the Ordnance Department at Washington, D. C., he served on the staff of Maj. Gen. C. M. Wesson, then Chief of Ordnance. Colonel Hodges has long been a member of the Association and a staunch champion of the Ordnance cause. His promotion is a source of pleasure to his many friends.

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### DR. WILLIAM O. HOTCHKISS RETIRES

DR. WILLIAM O. HOTCHKISS retired as president of Rensselaer Polytechnic Institute on October 1st. He had been president since 1935.

Dr. Hotchkiss was awarded the title of president emeritus for his "meritorious service . . . particularly in the establishment and execution of the extensive war service the institute has performed during the last three years."

A former president of the Michigan College of Mining and Technology, Dr. Hotchkiss was Wisconsin state geologist and chairman of Wisconsin's State Highway Commission.

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### POSTAL ZONE NUMBERS

MEMBERS of the Association and subscribers to ARMY ORDNANCE are requested to send notice of their postal zone numbers (if any) to the Executive Offices of the Association, 705 Mills Building, Washington 6, D. C., as soon as possible. This is a Post Office requirement, and it will also insure prompter receipt of ARMY ORDNANCE, the monthly Bulletin, meeting notices, and other communications from the national headquarters.

Members and subscribers who change their addresses should notify the Executive Offices of the Association at least three weeks before the publication date of the subsequent issue. If readers have notified the Association of their proper address within the specified time and still do not receive their copy, they must make claim for the missing copy within two months after scheduled publication. Claims for missing copies made later than two months after the publication date cannot be honored, as extra copies are usually exhausted by that time.

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### NECROLOGY

THOMAS ERBY KILBY, former Governor of Alabama and one of that state's leading industrialists, died on October 22nd at the age of 78.

Governor Kilby was chief executive of Alabama from 1919 to 1923 and was president of the Kilby Steel Company of Anniston at his death. He unsuccessfully opposed Hugo L. Black for the United States Senate seat which the latter held. In 1930, Governor Kilby was one of the organizers of the Birmingham Post of the Association.

Mr. Kilby took the oath of office as Governor on January 18, 1919. During the four years that followed, Alabama saw the beginning of her great highway system. With many business reforms, the state entered a period of industrial revolution unequaled in its history. One of the Governor's first moves was to establish a budget system for the state.

Governor Kilby abolished the lash for convicts and built the state prison near Montgomery—a model institution which bears his name.

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ARTHUR B. WHITTET, head ordnance engineer of the mobile-artillery section of the Ordnance Department, died on November 27th at his residence in Washington, D. C., at the age of 58.

A native of Texas, Mr. Whittet was graduated from Texas A. & M. College in 1903 with a B.S. degree. He came to Washington in 1909 to accept an appointment in the Ordnance Department and was subsequently promoted to head ordnance engineer. He held that post until his recent illness.

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NOTICE has been also received of the deaths of the following members of the Association: Wayne A. Baird, Houston, Tex.; John J. Brett, Brooklyn, N. Y.; John Otho Downey, New York, N. Y.; O. R. Fageol, Kent, Ohio; William B. Hannum, Sr., Valley Stream, L. I., N. Y.; Clarence H. Howard, Jr., St. Louis, Mo.; Mortimer S. Kashare, Elkton, Md.; Emil H. Kessler, Dayton, Ohio; F. T. Macrae, Jr., Cleveland, Ohio; George Masters, Philadelphia, Pa.; Frank W. Morhardt, West Hartford, Conn.; H. L. Myer, Shreveport, La.; G. G. Rheuby, Glenn Mills, Pa.; Samuel A. Stafford, Edgeworth, Pa.; Eugene T. Trotter, Brooklyn, N. Y. To their relatives and friends, ARMY ORDNANCE, on behalf of the Association membership, extends condolences and regrets their loss to the national defense.

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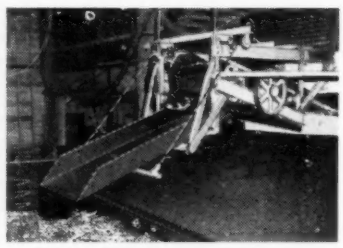
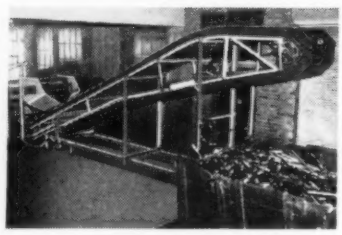


This photograph shows how the scrap is discharged directly into the cars for immediate shipment to scrap-salvaging plants. No trucks are used. No manpower is wasted.



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# Ordnance in Review

## THE MACHINE GUN—THE PERIOD OF RECOGNITION, PART VI

LIEUT. COL. CALVIN GODDARD

FOR whatever mental aberration lay behind his statement in the last installment of these papers (ARMY ORDNANCE, November-December 1943, p. 594) to the effect that "no specimen (of the Lowell machine gun) was purchased by the U. S. Government," the author sincerely apologizes. The inaccuracy of this observation is revealed by the figures in the table which shortly precedes it where it is shown that during the period 1878-1884, the U. S. War Department acquired a total of twelve Lowell guns of .45 (rifle-cartridge) caliber.

A test of the Lowell gun (Fig. 11) made at Sandy Hook in 1877 was mentioned in the previous installment. (The recommendations of the test board recorded there as referring to the 1877 trials actually followed the tests of 1878.) In the report of this test, the gun's general system of operation is so completely and so clearly described that it may well be quoted at length:

"The Lowell battery, or machine gun, is of the mitrailleur order. The system is composed of two distinct parts; *viz.*, the barrels, with their disks and trunnions, and the frame and breech, containing the mechanism. The barrels—generally four, although a greater number may be used—are mounted between two supporting disks, arranged to revolve in rings. The ring at center of barrels is provided with trunnions which work in the frame connecting the barrels with breech mechanism. The rear ring and inclosed disk, when the barrels are in position, lock with the frame. By this arrangement of the barrels they can be disconnected from the breech and tilted up, allowing them to be readily inspected or cleaned; also facilitating the extraction of any obstruction.

"One of the peculiar features of this gun is that the firing is confined to one barrel at a time, requiring but one lock. This barrel is used until heated, disabled, or clogged, when it is rotated aside by a simple lever movement and another brought into place, and this can be done quickly and without shutting off the feed. The upper barrel being the one fired, it is always in sight of the operator, and any damage to it, such as bulging or bursting, can be readily detected and its use in subsequent firings avoided.

"The breech mechanism is contained in a housing of brass, the lower half of which is securely bolted to the connecting frame, the cover or upper half being secured to it by hinges on the left side and on the right by catches when closed. This cover is in two parts, so that the whole breech mechanism can be exposed, or only that part of it which receives the cartridges from the feeding tube. The advantage of this arrangement is apparent. In about fifteen seconds the cover can be thrown open, and the working parts, which occupy but little space and are exceedingly simple and strong, can be removed and replaced without tools by any man of ordinary capacity. The principal parts of the breech mechanism are the crankshaft and worm for rotating feed or carrier rolls; the lock-plunger with its firing pin, firing-pin spring, and two extractors; two carrier rolls and shafts with gearing, and the feeding tube.

"The crank works from the rear, and for purposes of drill or exercise the machinery can be reversed without change. The lock-plunger has two strong extractors, operating positively and not depending upon springs. These extractors grasp the cartridge

Colonel Goddard is chief of the Historical Section, Office of the Chief of Ordnance, and a member of the board of editors and advisers of the Encyclopædia Britannica.

shell on opposite sides and remain locked until the shell is fully withdrawn. The firing pin has an elongation pointing downward which, as the worm rotates, is forced back by a cam on the worm, compressing the spring. The moment the firing pin is released, it strikes the primer of cartridge, and discharge takes place. The carrier rolls are simply two cogged wheels, revolving in opposite directions, and so arranged as to receive between their teeth the cartridges delivered from the feeding tube; the rolls carry the cartridges between plunger and chamber of barrel, receive the fired shell, and, by further movement of crank, force the shells to fall to the ground. One entire revolution of the crank fires and extracts three cartridges.

"The feeding tube consists of an upright brass tube, firmly set in a socket directly over the carrier rolls; it can be removed, if necessary by loosening a setscrew at its lower end. This tube has a slot on its forward side, extending its whole length, of a width slightly greater than the diameter of the cartridge. It is also slotted on its interior to receive the head of the cartridge,

FIG. 11. THE LOWELL MACHINE GUN

being slightly trumpet-shaped at its top to facilitate the introduction of the cartridge. It will hold about thirty cartridges. In the socket which holds the feeder is a stop with a milled head, normally held back by a spiral spring that allows the cartridge to fall. Should it be desirable to stop the feed, the operator pushes in this 'stop,' turning it slightly to the left, it being held in that position by a small pin entering a slot. There are also provided for service with the gun feed-cases of tin, holding seventeen cartridges each; the cases are made by simply turning a piece of tin about one inch wide so as to hold the heads of the cartridges by their flange; pieces of steel bent over the ends of the case and soldered to it hold the cartridges in place. By placing the case in 'feeder' and pressing on the top cartridge, the steel spring is forced back, and cartridges drop into place."

During the test in question, in the course of which 14,905 cartridges were fired, a number of ammunition malfunctions were noted. In addition, "when changing barrels so as to bring another into use, the lever and spring did not (always) bring the fresh barrel exactly into line with the jaws of the rolls, so that when the cartridge was pressed forward the bullet caught in the barrel and jammed there, and cartridge was exploded by pressure of block behind it."

The board commented on the design and function of the weapon as follows: "The principal features of this gun, different from those used in other systems, are the feed, the double extractor, and the accessibility of parts—features possessing much

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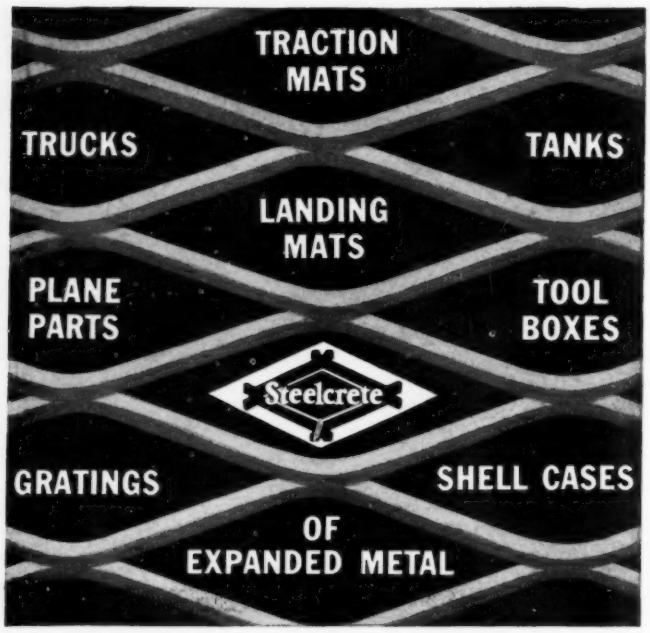


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## Ordnance in Review

merit. The carrier rolls prevent the accumulation of cartridges before the lock, receive the shells as they are withdrawn from the barrel and carry them clear of the gun, all their movements being positive and certain. The extractors, from the construction of the 'lock-plunger,' are obliged to retain hold of the flange of the cartridge until the shell is delivered to the rolls, clear of the barrel. The working parts of the gun, being so accessible, can be quickly removed for repairs or cleaning, and, in case the gun should have to be abandoned in the field, can be readily disabled by removal of mechanism. The only parts liable to disarrangement or that generally require cleaning are the 'lock-plunger' and the two 'carrier rolls.' The barrels, not being made fast to the framework, can be 'tilted up,' making inspection and cleaning an easy operation, but a want of stability and a sacrifice of accuracy result. . . .

"The board recommends that a new gun be made for trial, embodying any improvements deemed practicable and desirable by the inventor, but more especially those looking to the insuring of increased accuracy of fire and increased stability of the system; the gun and carriage to be ordered by the Department, and the board to be consulted as to general features and details of the system."

In conformity with the above, another trial model was produced by the Lowell Company and tested on April 9, 1878. Somewhat over 10,000 rounds of ammunition were fired and a material improvement in accuracy and efficiency was noted.

According to Farrow's Military Encyclopædia (Vol. II, p. 235), the U. S. Navy had adopted the Lowell gun prior to the date of publication of this work (1885); Russia had likewise purchased twenty specimens for its navy, and California had bought three for issue to its state prisons. The weapon therefore appears to have met with some little acceptance.

But the days of the hand-operated machine weapon were already numbered when Farrow's comments on the Lowell appeared in print. For the recoil-operated Maxim was now a reality. As indicated in an earlier installment of these papers, it receives considerable attention in Farrow's work (although much less than he devotes to the Lowell).

THE Maxim of this period was of .45 caliber and possessed a cyclic rate of fire of about 600 rounds a minute. It weighed, less its carriage, some sixty pounds and had an over-all length of fifty-seven inches. Cartridges were fed from a belt or a drum.

Maxim was not the first to attempt to harness the forces of recoil and put them to work at operating a gun mechanism. But he was definitely the first to produce a successful machine gun on this principle. Without fundamental changes, his weapon has been reproduced in model after model from 1884 to date. Farrow's appraisal of the first specimen can, therefore, be considered as generally applicable. It reads: "The gun may be described as follows: It has a single barrel, arranged in such a way as to recoil slightly in its bearings, the force of recoil of each round acting on the feeding and firing gear so as to load and discharge the next round, and so on, round after round, in succession. That is, the force of recoil extracts and ejects the empty case, brings the next round into position, pushes it home, and cocks and liberates the striker. The barrel recoils 9/16 of an inch, with its breech held firmly closed. This gives the bullet time to escape and fly about a hundred feet so that the gases have also abundant time to escape after it has left the muzzle. Then a locking hook, which has held it close, is opened, and the barrel is stopped, while the breech (block) and extractor run on, carrying the empty case with them. This is ejected, and the succeeding round brought into position by a feed wheel, when the return stroke given by a connecting rod sends the charge home, closing the breech, pushing the barrel forward into a firing position, and finally releasing the striker which fires the round. The recoil of this round repeats the above movements, and so on, as long as filled cartridges

## Ordnance in Review

are supplied and fired." (In the operation of the modern British Maxim, however, recoil energy is augmented by gas pressure.)

With the introduction of the Maxim, the star of the hand-operated machine gun commenced to decline. (Fig. 12 illustrates the Mark III British Maxim of about 1897.) The United States clung to its Gatlings to and through the Spanish-American War of 1898. Indeed, this gun was a standard article of issue as late as the early 1900's. Even so, it already had been receiving severe competition for a number of years in the form of Browning's gas-operated gun as produced by the Colt Company and perfected as early at 1895. (The Maxim, though invented by an American, was never officially adopted by the U. S. Government.) While basically different in its mode of operation from the Maxim, the Browning was, like the latter, wholly self-actuated, and the competition offered the hand-operated type of weapon by the recoil-operated Maxim plus the gas-operated Browning and other similar weapons soon became overwhelming. In spite of vigorous

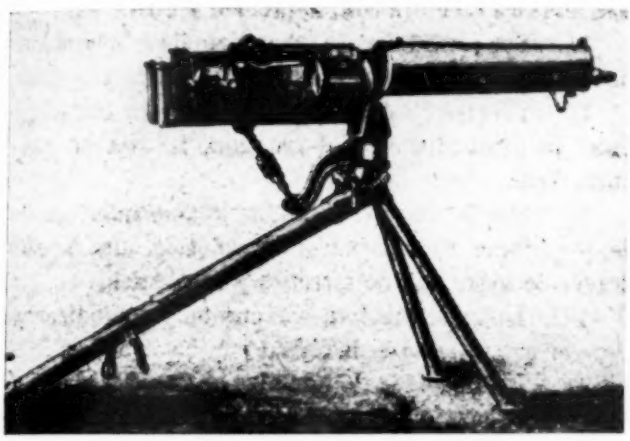

FIG. 12. THE MAXIM MACHINE GUN

efforts to keep it in the field, the hand-operated variety was already moribund at the turn of the century. By the end of the next decade it was, to all intents and purposes, wholly out of the running.

The period of 1860-1885 therefore covers, for all practical purposes, the active life span of the hand-operated machine gun. Given its brilliant initiation by Richard J. Gatling in 1862, it soon engaged widespread interest, and several successful types, built on widely differing principles, appeared. Despite the ill repute acquired by the tactical misuse of the mitrailleuse in the Franco-Prussian War, some form of hand-operated machine gun was sooner or later adopted by practically all civilized nations. It was a colorful weapon and had a colorful history. Though constantly misused tactically throughout its entire existence, its potential usefulness was so apparent that its eventual acceptance was certain. It is a weapon that will live long in the minds and memories of military men.

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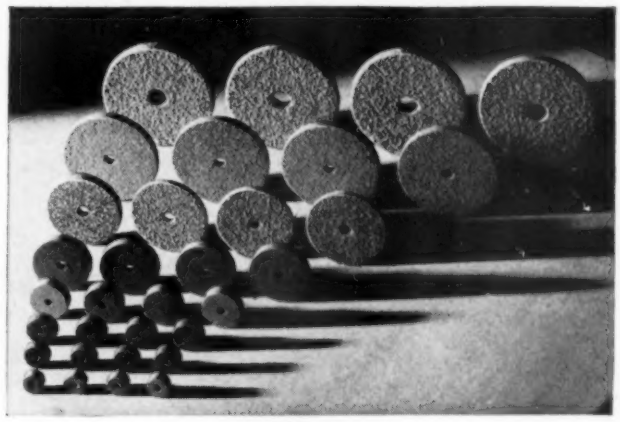
EDITOR'S NOTE.—This is the sixth and last of Colonel Goddard's articles on "The Machine Gun—The Period of Recognition" which began in the March-April 1943 issue of ARMY ORDNANCE. These articles will be prepared in brochure form and copies may be obtained upon request when available.

With his description of the Maxim machine gun, Colonel Goddard brings to a close this third series of papers on machine guns, the first of which (The Machine Gun—Its Early Applications) was begun in the September-October 1941 issue of ARMY ORDNANCE and concluded in the March-April 1942 issue. The second series, entitled "The Machine Gun—A Period of Evolution," was begun in the May-June 1942 issue and concluded in the January-February 1943 issue.


FOR QUICK ACTION



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# Professional Digest

## Transition from Riveted to Welded Tank Construction

William Osha

THE light combat tank has proved itself in many theaters of this global war. Let us consider here its construction and the part that welding has played to make it a more effective instrument of combat. In the fabrication of riveted tanks, armor plates of various thicknesses, shapes, and contours are assembled by riveted butt-strap construction. The butt straps are fabricated from structural shapes and strip. The plates are gas-cut to shape; then planers and shapers accurately cut the abutting edges to make a tightly fitting joint. Brakes and hydraulic presses form the plates to the desired contour and holes for riveting are carefully drilled to template.

The fabrication of welded combat tanks of the same design differs in the elimination of the butt straps and the rivet holes in the armor plate for assembly and in the additional double beveling of the armor-plate edges by oxyacetylene beveling machines.

The substitution of the welded joint revised armor-plate-edge preparation. Oxyacetylene-flame shape-cutting machines as production tools relieved the planer and shaper and in most cases produced a satisfactory edge and bevel for the welded joint. The design permitted 90-degree flame cutting of all plate edges to dimension; 30-degree, 45-degree, and 60-degree beveling in the same plane, when properly guided, furnishes a satisfactory edge for welding.

The gas shape-cutting machine has proved itself more efficient and more economical than planers and shapers, not only in cutting sixty pieces of armor plate per tank but also in double beveling a great many of these plates in the welded design. This may not seem impressive for the individual tank, but the gas cutting machine as a duplicator is most efficient in the production of over 1,000 tank sets of armor plate a month.

The application of approximately eighty gas shape-cutting machines of various types to armor-plate fabrication required a great deal of patience and perseverance in order to get an efficient setup and economical results. Ordinarily, sufficient accuracy may be obtained by burning direct from the pantograph rather than from "riding the plate." Arrangement of cutting so that the torches ride a template attached to the armor plate being cut maintains a tolerance to one thirty-second of an inch and consistent duplication. Gas cutting of homogeneous armor need not be followed by flame softening, but welds can be made directly to the gas-cut surface provided all heavy scale is removed by touch grinding.

The combat tank consists of two units—the hull and the turret. The original turret of riveted design was made up as a polygon with eight sides from flat armor plates, the two long sides focusing toward the front gun-shield plate. The turret cupola was a 6-sided polygon, two sides being vertical extensions of two sides of the turret proper. The assembly of these plates in a strong integrated unit required many miter joints with abutting edges cut very accurately at various angles in a planer or shaper setup. All plates required in the integral unit were drilled by jig preparatory to assembly by countersunk-rivet butt-strap construction. There were 220 holes drilled and reamed, and 220 rivets driven for each turret.

When the American Car and Foundry Company was asked to weld some armor-plate samples the company knew of no one who had any experience in welding face-hardened armor. After

Mr. Osha is general welding foreman at the Berwick plant of the American Car and Foundry Company. He was assisted in preparing this paper by John W. Sheffer, general electrical engineer of the company.

trying several different joints and electrodes, it was finally decided to butt weld with a double-V joint two plates approximately 18 x 36 inches to form a test plate 36 inches square. (This was some time before the H plate was proposed.) The weld was made originally with special electrodes with two beads of hard-surfacing electrodes on the face side. The ballistic tests of various butt-welded joints (which were primarily for resistance to penetration) developed a joint 85-90 per cent of that of the armor plate itself; the double-bevel butt-welded joint was then substituted for the riveted butt-strap construction on the 8-6-sided polygon turret design.

The jig assembly of these armor-plate segments into the 8-sided polygon permitted tacking these plates together after a buttering bead was applied at the root gap edge before plates were placed in jig, leaving a ⅛-inch separation at the root for the first multiple-pass hand welding and a root gap opening on the inside of 30 to 45 degrees and on the outside of 45 to 60 degrees. This permitted complete penetration of the root passes. This design of lapping the plates in several positions used a double fillet weld—one on the inside, the other on the outside. The outside fillet with a vertical lap gave little concern regarding ballistic impacts due to its position. The horizontal lap on the floor in most cases permitted double side and edge fillets equal to the thinner plate.

THE first welded turret was a quick change-over from the riveted design by double beveling six abutting vertical edges and proceeding to weld these joints by the best technique then available for armor-plate welding. However, the excess man-hour welding time for multipass double butt welding of six seams of about thirty inches each suggested a turret of new design adapted for welding wherein two semicylindrical formed homogeneous armor plates had one vertical double butt-welded joint with the long sides focusing toward the front gun-shield plate. The cupola was semicylindrical with two vertical butt-welded seams and a horizontal butt and fillet weld attaching it to the turret top. Welded attachment of the base ring and guard together with peek door frames created an integrated unit. This welded design was produced for about a year.

A welded turret with a bulge in the rear was put into production early in 1943. This entirely new design was necessary due to requirements for increased space in the turret. The two homogeneous formed side plates were gas cut horizontally, and the bottom section was formed into a circle to which the base ring is attached. The upper section projects to the rear to form the bulge and is also focused forward for attachment to the front gun-shield plate. Roof and floor attachments complete the turret unit.

The attachments just referred to in this design require four multiple-pass double butt welds, two extending the back-plate attachments to the side plates and two extending the side-plate attachments to the front plate. Sections through the principal welded joints show from six to eight multiple passes, three of which are hard-facing.

Production demands attention to the creation of proper jigs and positioners in order to give the welder every advantage in man-hour output and at the same time enable him to produce a weld of the highest quality. Fillet welds continue in use for lap joints and certain attachments such as handles, hoisting eyes, guards, plate reënforcements, retainers, segment gussets, strap hinges, and supports. These fillets vary in size from one-fourth to three-fourths of an inch. As more was learned about welding armor plate, it was found that the saying, "A bad welding job is better than a good riveted one," gradually was heard less and less. Emphasis was placed on making welds that approached the strength of the parent plate, and resistance to penetration became secondary to shock resistance.

In welding face-hardened armor, the operator is confronted with essentially two metals: the core, which has a low carbon content, and the face, which has an extremely high carbon content. Welding this outside face with hard-surfacing electrodes to pro-


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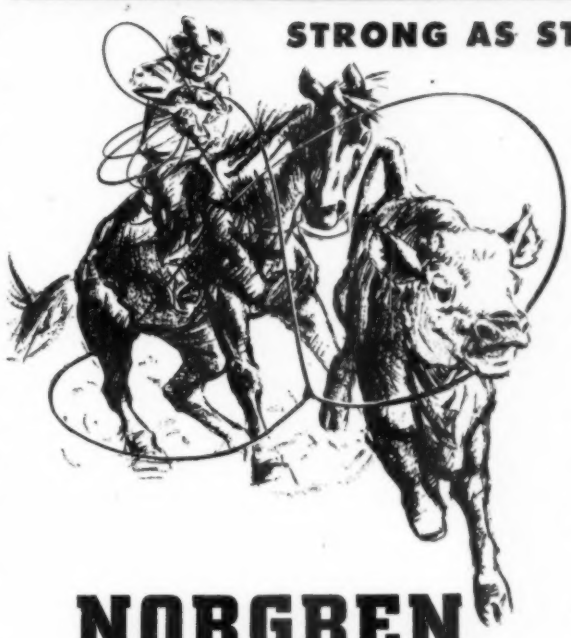

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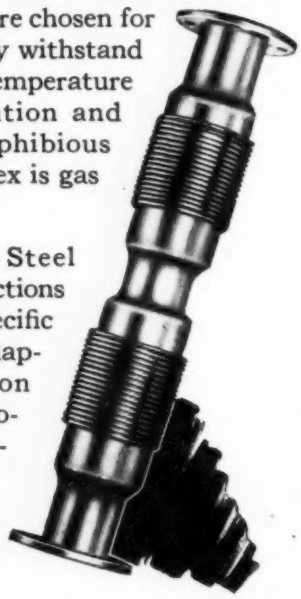

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duce resistance to penetration is not so difficult, but the weldment has little ductility and therefore little value for shock resistance. There finally was developed what is known as masking. The plate edges that are to be welded are sprayed with a copper coating which prevents them from absorbing more carbon in the carburizing process. The welder is now no longer confronted with a bi-metal, but can proceed using practically the same technique employed in the welding of homogeneous tank armor plate.

The transition from the riveted hull to the hull of welded construction required additional manufacturing space and different equipment such as special welding jigs, welding positioners, hand-welding machines, and automatic plug welders. Plug welding was substituted for all horizontal riveted attached butt-strap angles which eliminated exposed rivet heads. A plug-welding setup produced welds in a few seconds at 800 amperes through the use of push-button electronic-controlled welding heads operating on ball-bearing carriages. This operation caused the operator little fatigue.

THE design of the welded hull permitted the transition program to be executed in three steps with practically no reduction in daily output. Step one specified: (a) all sponson connection angles to be plug welded to sides; (b) top and bottom plates of the sponson to be riveted in the final assembly; (c) front T section to be welded to the side; (d) all hinges to be welded to doors and door frames; (e) the rear top angles which take the top plate to be plug welded to the sides up to the curved rear hood. Accumulation of these welded subassemblies for several weeks permitted their substitution without loss of production.

The second step required: (a) rear hood to be formed and angles plug welded to the side—the formed armor plate was slightly modified in design to facilitate welding assemblies; (b) the entire front cover plate which protects the bow gunner and driver to be changed to welded construction; (c) the bottom sponson plate to be flanged and plug welded to the inside of the side plate. The transition on this second step was made without loss of production.

Change-over to a complete welded hull in the final step included the entire sides of the hull, which meant (a) the plug welding of the bottom side angles; (b) welding the side rear angles to the side; (c) welding bulkhead angles and gasoline-tank pocket; (d) butt welding the two side sections, eliminating the butt straps; (e) changing the two vertical seams on the sponson from plug butt strap to full butt weld. For production reasons in the final assembly, the top plate and the bottom or floor sheet are riveted to the connection angles. These are vertical rivets.

After several weeks of planning, purchase, and rearrangement of machines and equipment, the transition to this welded design was accomplished in the midst of a very large daily production without interruption or loss of production. In fact, in one case, production was actually increased three tanks a day over the previous output.

Resistance spot welding of satisfactory ductility has replaced many exposed rivets in light sheet-metal assemblies, such as sand guards, boxes, and brackets required on the tank. Eleven spot-welding machine days were required for normal tank production.

As the result of this transition from riveted to welded construction, the U. S. Army now has a light combat tank with more protection to its crew. It is more heavily armored in front and has sponsons which slope twenty degrees—equivalent ballistically to an additional ⅛-inch thickness of armor plate. It has a flat all-welded turret which is "right" ballistically; is better streamlined, and is lighter in weight—thus giving greater horsepower per pound and extending the cruising range.

## Professional Digest

### NEW U. S. WEAPONS

AS the war goes on, more and more evidence appears to show that the designers of arms and equipment for American troops were far from caught napping by World War II. From the very outbreak of hostilities, American matériel was at least the equal of that of any of our enemies; now, as the changing theaters of war demand new requirements in weapons, American inventiveness and ingenuity have come into full play and are producing a veritable flood of weapons that far surpass anything the enemy can hurl against our forces.

The Ordnance Department of the Army alone has over 1,000 new weapons under development and undergoing battlefield tests for the final assault on the Axis. Contracts have been let with almost 400 laboratories, engineering organizations, universities, and industrial companies for research and development work on battle tools, automotive vehicles, and ammunition.

Thousands of Ordnance contractors in various parts of the country have been mobilized through eighty-five special committees to work continuously on the improvement of production designs and methods. More than a thousand suggestions of employees in Ordnance-producing facilities have thus far been adopted and put into effective operation. The National Inventors Council of the Department of Commerce has given the Ordnance Department access to the suggestions of the general public for new or improved methods of production and for new or improved war weapons. Of approximately 152,650 inventions submitted to the council and reviewed by it as of July 1, 1943, over 50,375 pertained to ordnance items. Six of these inventions have been approved and are now in production, while about fifty-nine are being developed and tested.

Some of the new devices fostered by the Ordnance Department and other branches of the Army are described below.

### A NEW ANTIAIRCRAFT DIRECTOR

A NEW antiaircraft-gun director, the M9, recently has been developed by Bell Telephone Laboratories and has been adopted by the Army. Like other directors, the new instrument aims the guns of an antiaircraft battery and adjusts the fuze setters so that the shell will burst when close to its target. It differs from other directors in that it employs electrical circuits instead of mechanical movements to make its calculations.

The new director was conceived by Dr. David B. Parkinson of the Bell Company who was assisted by his associate, Dr. Clarence A. Lovell. Funds for a pilot model were allocated by the National Defense Research Committee and, after endorsement by the Antiaircraft Artillery Board, the device was put into production at the Western Electric Company under the auspices of the Ordnance Department.

In the art of ranging on a moving object, the electrical director represents a considerable advance in several particulars. It has solved the difficult problem of compensating for the errors introduced by the human element. There is a natural tendency for an observer operating a director to permit the target to stray from the cross hairs in the telescopes. Realizing that this has occurred, the observer attempts a quick recovery which may be interpreted as a change in the speed of the target. If this information were used, the gun would quickly change its lead to fit the false rate of speed. Engineers of the Bell Telephone Laboratories have long been familiar with electrical networks for telephone systems, so they invented a brand-new one by which the momentary fluctuations are averaged out, and the electrical director considers only the smooth rate reported over a period of several seconds. Another characteristic of electrical apparatus which is particularly fortunate in wartime is the possibility of building it to high accuracy with ordinary shop personnel and production methods.

At army camps, flying fields, and training centers all over this country and many other countries vital to Allied defense, Cletracs are "doing their duty"—like good soldiers. Road building, bulldozing, hauling—moving earth, stones, and trees to make army defenses and training fields stronger, safer, smoother, for the all-out drive for Victory.

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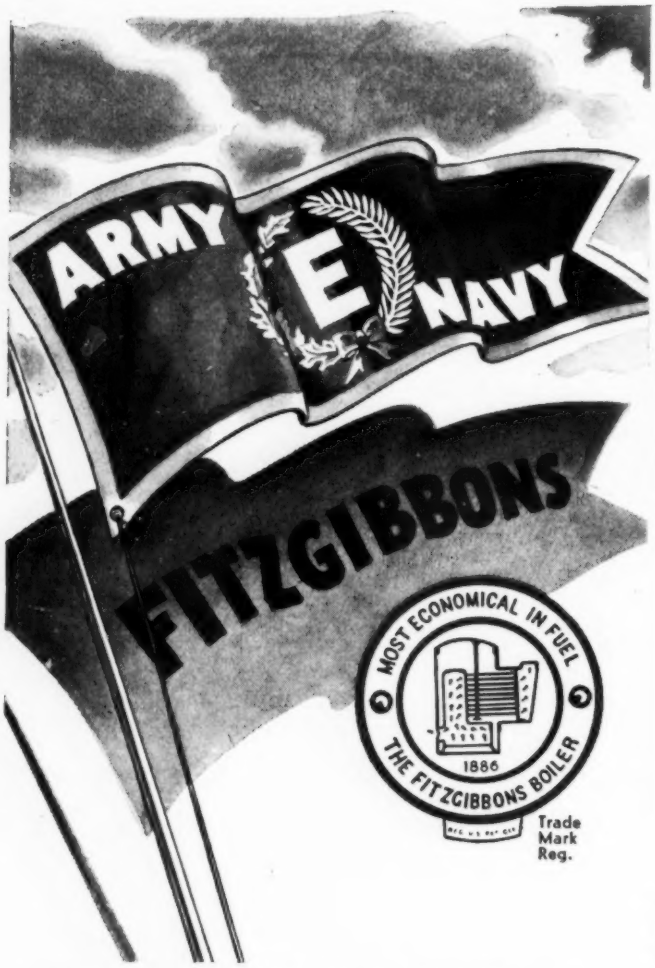


**The Army-Navy "E" pennant now flies over the Fitzgibbons plant, emblem of sustained endeavor by the men and women of Fitzgibbons, and of their determination to maintain the Fitzgibbons standard of wartime production, until the forces of international banditry are smashed.**

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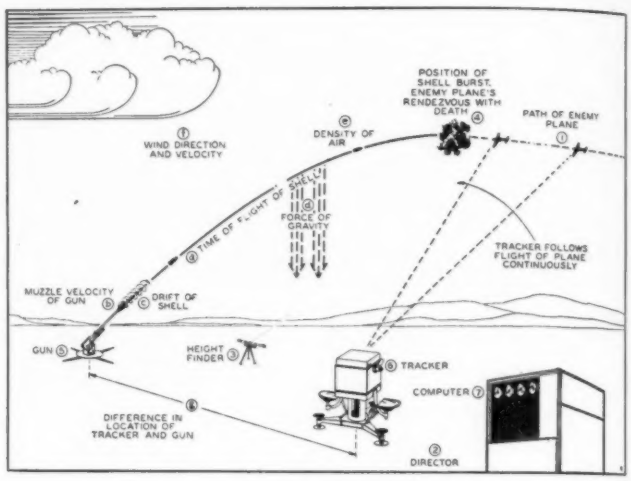
How the electrical director works is visualized in the accompanying illustration: An enemy plane (1) looms in sight. The crews of the tracker (6) and of the height finder (3) spot the target and follow it in its flight. The computer (7) of the electrical director instantly measures the position of the target and then predicts where the antiaircraft gun (5) is to be aimed and how the fuze of the shell is to be set so that the shell will burst in the path of the plane at the predicted position (4).

The electrical information derived by the computer is translated into mechanical movement at the gun to swing its muzzle


POSITION OF SHELL BURST, ENEMY PLANE'S RENDEZVOUS WITH DEATH ④
PATH OF ENEMY PLANE ①
WIND DIRECTION AND VELOCITY ⓕ
DENSITY OF AIR ⓔ
TIME OF FLIGHT OF SHELL ⓐ
FORCE OF GRAVITY ⓓ
TRACKER FOLLOWS FLIGHT OF PLANE CONTINUOUSLY
MUZZLE VELOCITY OF GUN ⓑ
DRIFT OF SHELL ⓒ
GUN ⑤
HEIGHT FINDER ③
TRACKER ⑥
COMPUTER ⑦
DIFFERENCE IN LOCATION OF TRACKER AND GUN ⓖ
DIRECTOR ②

OPERATION OF THE ELECTRICAL DIRECTOR

automatically to the correct horizontal and vertical angle to score a hit. Not only must the computer make its calculations continuously during the entire period the target is being tracked, but it must make constant and instantaneous corrections for a number of factors such as the following:

The time of flight of the shell (a) to the predicted position of the target (4), is dependent upon the muzzle velocity of the gun (b), which in turn is governed by the temperature of the powder and the number of times the piece has been fired. The path of the shell is also influenced by its drift (c) which is the spin caused by the rifling of the gun, curving the shell to the right. At the same time the pull of gravity (d) deflects the shell downward, and the varying density of the air (e) slows down the projectile more or less, while the direction and the velocity of the wind (f) either retards or pushes the shell ahead or to one side. To add to the complications of the problem, the difference in the location of the tracker and the gun (g) must also be taken into account. The electrical director makes all these calculations almost instantaneously.

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### ARMY'S NEW BOMBER DESIGNATED B-29

CERTAIN details of the Army's newest superbomber—the B-29—have been revealed officially by the War Department. Gen. H. H. Arnold, Commanding General of the Army Air Forces, said of the new plane:

"The B-24 Liberator, pioneered by Consolidated, and the B-17 Flying Fortress, pioneered by Boeing, are superbombers on the basis of their superb combat records. We now have a third superbomber which is as far ahead of those two aircraft as they are out in front of prewar bombers. It is the B-29, developed by the Boeing Aircraft Company in close coöperation with the Army Air Forces and its Matériel Command and evolved in secrecy during the past several years."

The engineering of the B-29 design was accomplished by the Boeing Company's engineering staff at Seattle, Wash., where the

## Professional Digest

first experimental models were built. Engineering and production information has been turned over to other major aircraft manufacturers, who also will produce the plane through final assembly, and to other industrial concerns which will handle subassembly or parts production. This battleship of the air is armed heavily with multiple-gun and power turrets. It can fly at very high altitudes.

Its performance will not be discussed before it enters combat; however, the B-29 will have a range substantially greater than the maximum effective range of today's longest-range heavy bombers, and it will carry quite sizable bomb loads for that distance.

"When it enters combat," General Arnold stated, "today's long range will become medium range, and today's heavy bombers will consequently become light heavies. Even under the impetus of war, many months must elapse between the adoption of a plane type and its entry into combat. These months are needed for development, to prepare for production, to increase production, to train personnel, and to iron out the 'bugs' inherent in all new types. Eventually, however, sufficient planes and crews are ready to give the weapon its final test—under combat conditions. That final test of the B-29 is not now far distant. It should be made clear that production of B-17's and of B-24's will not be affected by advent of the B-29. Production of those two bombers is being increased steadily."

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### Stratosphere Range to Test Large-Caliber Aircraft Cannon

NEW heavy-caliber aircraft cannon soon will pump their shells over the world's shortest firing range—a distance of twenty-two feet—as engineers at the Eglin Field, Fla., Army Air Forces proving ground test the effectiveness of the big guns in a man-made stratosphere seventy degrees below zero.

The firing range will consist of twin steel vacuum chambers where temperature and air pressure will duplicate the stratosphere nine miles above the earth. In the contest to equip high-altitude bombers with bigger and bigger caliber cannon and machine guns, aircraft designers must know more about the effect that lack of oxygen and subzero weather have on detonation and the speed of projectiles. With this newest application of the stratosphere chamber they can study at close range conditions which ordinarily could be observed only in actual combat.

A modern stratosphere bomber rising from sea level to 40,000 feet endures a 140-degree drop in temperature in a few minutes. This causes a terrific shock contraction of all metals, many of which will contract at different ratios. It is important to know how this affects firing mechanisms and gun barrels. Likewise, at 40,000 feet the atmosphere approaches a near vacuum and makes possible greater speed for a projectile because of less resistance from the weight of air. The effect of low moisture content on delicate firing mechanisms and the concussion produced by big guns in rarefied air are among other questions which can now be studied.

Two steel cylinders and a concrete sand trap will make up the stratosphere firing range, the whole covering a distance of only fifty feet. Even the shells from a 75-mm. cannon fired through the frigid artificial stratosphere can be stopped after they have traveled the length of the range. Two men equipped with oxygen masks will enter the main strato-chamber to operate the big guns. For each maximum test, temperature will be dropped from 70 degrees above to 70 below zero in 12 minutes while air pressure is reduced to a partial vacuum of 2.2 pounds per square inch. In the concussion chamber ahead into which the muzzle of the gun projects, temperature will be maintained at 67 degrees below zero.

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Universal Cooler design and producing experience that is helping to "freeze out" the Axis now—will be equally ready when America turns to post-war home industry.

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**Hydro-Sealed** by floating water blanket, new high-performance Carbon Gum Digestive Solvent cleans carbon and paint from aircraft engine parts without harmful effect. Used hot, water seal prevents escape of solvent vapors. (Data Sheet # 236)

**High-Potency Concentrate** makes Self-Emulsifying Grease Solvent to remove insulating coats of grease and dirt from truck, jeep, tank, and automobile engines by emulsification and utilizing the heat of a warm engine. Cleaned engines operate more economically since original thermal efficiency is restored. (Data Sheet # 237)

**Unique Oil** removes salt; may be applied to metal surfaces wet with sea water. Cleans, dehydrates and leaves thin film of rust-preventive compound. Suitable as a cleaner-preservative and lubricant for small-arms bore cleaning. (Data Sheet # 238)

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**New Fuel Concentrate** raises low-test gasoline to high anti-knock rating motor fuel . . . especially applicable for high-compression motorcycle engines . . . increases performance. (Data Sheet # 241)

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**Emulsifying Compound** cleans oil from camouflage paints; restores dead, flat, lusterless surface. Shipped as a concentrate. (Data Sheet # 243)

**Instrument Shampoo** emulsifying solvent cleans optical lens and delicate mechanisms without harmful effect. Results in physically clean work and complete absence of any film. (Data Sheet # 244)

**Fluid, Pre-Paint Cleaning** extracts and emulsifies all traces of wax, oil, and grease from hard surfaces. Rinses with water . . . leaves no film. (Data Sheet # 245)

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***Confidential formula bulletins will be made available whenever the particular purpose and use that the formula is to serve is described.***

## Professional Digest

### NEW "CHIN TURRETS" FOR FLYING FORTRESS BOMBERS

A new "chin turret" to strengthen defense of America's Flying Fortresses against frontal attack from enemy fighters is now in volume production. The new 2-gun turret was developed by the Bendix Aviation Corporation in conjunction with the U. S. Army Air Forces.

The electrically powered turret mounts two caliber .50 machine guns which can be controlled through a wide arc from side to side and can be elevated or depressed by the operation of simple control handles to meet attacking enemy planes from either side and from above or below, within automatically controlled limits. The turret is mounted at floor level in front of the bombardier's compartment. The bombardier, or a turret gunner, operates the guns which extend below the fuselage at the nose of the bomber and just below the plexiglass "greenhouse."

### THE 4.2-INCH CHEMICAL MORTAR

GERMAN 88-mm. guns are thirty times heavier than 4.2-inch Chemical Warfare Service mortars and have four times as much range, but a unit of the mortars recently knocked out a battery of the Nazi 88's in Italy. It took twelve shots from the mortar unit to do the job. The mortars, 300-pound weapons that can be moved by hand into inaccessible places where heavier artillery pieces cannot be set up, were fired against the 88's when it was found that no other allied artillery was immediately available.

The 4.2-inch chemical mortar, a comparatively new weapon on foreign battle grounds, fires either smoke, white phosphorus, or high-explosive shells. The high-explosive shells, each weighing twenty-five pounds, have the destructive effect of a 105-mm. howitzer shell. The mortar can fire twenty rounds a minute. The barrel of the weapon is rifled, increasing its accuracy over smoothbore mortars, but it is loaded from the muzzle like other mortars. Fired in units by combat troops of the Chemical Warfare Service, the mortars are used as light artillery support weapons rather than as infantry weapons like the smaller mortars.

### SMOKELESS BALL POWDER

AXIS soldiers won't ask for a second helping of the "black caviar" now in quantity production. The "caviar" is ball powder —a smokeless gunpowder in the shape of minute spherical pellets made by a revolutionary new process five times faster than ordinary smokeless-powder manufacture.

Ball powder is manufactured chemically under water by a patented new technique which reduces to a minimum the hazard in the making of smokeless powder. Although experimental lots of ball powder were manufactured by the Western Cartridge Company at its East Alton plant several years ago, its existence has been one of the ammunition industry's most closely guarded trade secrets. Unknown to them, many American peacetime shooters have been using ball powder in shot shells and other ammunition for some time past.

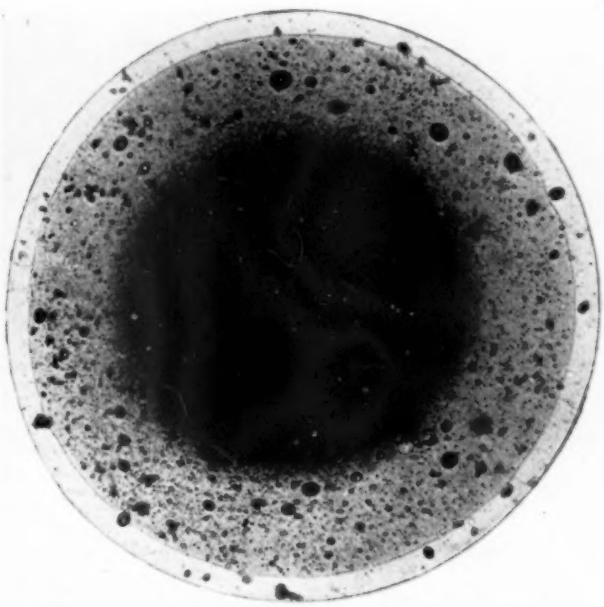
The British Government was the first to use ball powder in military ammunition. After the disaster of Dunkerque, when only private companies in this country were in a position to turn out gunpowder in large quantities, Western Cartridge Company built a ball-powder plant for England. This plant, constructed with phenomenal speed, was started in September 1940 and was completed four months later. Ball-powder plants have been built with great rapidity because the "stills" and other equipment required are made of materials available locally and have been assembled by local boilermakers.

When America began its rearmament program, the ball-powder patents were immediately offered to the War Department which authorized the company to use the new process in all am-

## Professional Digest

munition for which it is suitable. Since then, ammunition loaded with ball powder has been widely used by the allied troops. More than one billion military cartridges for the United States and other allied nations have been loaded with the new-type powder.

Where the manufacture of ordinary smokeless powder requires fifteen days, ball powder is being produced in quantity in only three days. Where other powder is handled dry in large quantities, ball powder is manufactured in ten times its bulk in



MAGNIFIED SECTION OF A GRAIN OF BALL POWDER

water and, when finished, is handled dry in small quantities only a fraction of the usual time.

Ball powder was developed by the technical department of Western Cartridge Company, headed by Dr. Fred Olsen who formerly was a chemical coördinator for the Ordnance Department at Picatinny Arsenal, where he was in charge of research and development of powder and explosives used in American military ammunition.

In the manufacture of ball powder, nitrocellulose is produced in the conventional way by the use of nitric and sulphuric acids. While immersed in ten times its bulk in water, the nitrocellulose is reduced to a pure liquid form by various chemicals, including ethyl acetate, a substance used in women's nail polish. Being lighter than water, the gelatinized nitrocellulose rises to the top of the water as a creamy lacquer. By stirring the mixture, the nitrocellulose lacquer acts in water very much as olive oil does in vinegar and forms into globules—the tiny ball-powder pellets. Other chemicals are added to the mixture to prevent the balls from reuniting with each other when the stirring is stopped. By controlling the speed of stirring, the powder balls can be made in a great variety of sizes suitable for a wide range of ammunition.

### COTTON MACHINE-GUN BELT DEVELOPED

AN all-cotton belt, augmenting the metallic-link belt, has been developed for American machine guns. The new belt has great tensile strength and flexibility, is compact, easy to load and easy to salvage, insures cleaner ammunition, and saves thousands of pounds of critical steel and countless man-hours in production schedules.

The belt must be tough and rugged because of the nature

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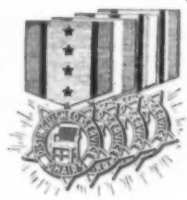

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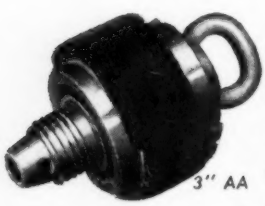
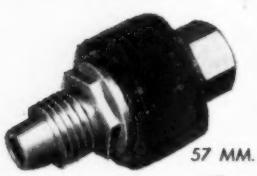
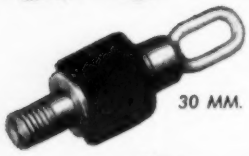

3" AA

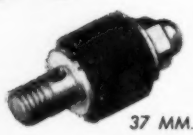
Above is shown the popular 155 mm. brush such as is used for the famous Long Tom Gun. Other size brushes are used for anti-aircraft batteries, tanks, and pack howitzers. Brushes are also provided for cleaning breech mechanisms and elevating gears.


57 MM.

Fullergript Brushes are made to Naval Gun Factory specifications from the one-pounder size up to the six inch gun.


30 MM.

We act as prime contractor or can sub-contract brushes or parts to manufacturers of carriages and accessories.


37 MM.

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## Professional Digest

of the machine gun itself—a steel pawl advances the belt by contracting and pushing one loaded pocket forward at a time. The rate varies from 500 to 1,200 rounds a minute. The belt also undergoes severe strain in the loading operation because the pockets are woven undersize and the cartridge is forced in. The belt must also stand up under all kinds of weather conditions, and this calls for careful chemical treatment.

The caliber .50 belt has a new development, making possible continuous firing. A plastic is applied to the ends which are then cut in such a manner that belts can be coupled or hinged together by means of a cartridge. Thus, two or more belts can be joined together and ammunition boxes of various sizes used in packing without inconvenience. This interlocking end also makes possible a dispersible belt for aircraft use, several short lengths being coupled together.

### Sawdust Used in Gas Mask Canisters

INTENSIVE research by the Chemical Warfare Service has produced a superior domestic substitute for imported material used in gas-mask canisters. Formerly, activated charcoal produced from coconut shells had been the ingredient used in the canisters, but, long before Pearl Harbor, Army officers, realizing the possibility that the supply of this raw material from the South Seas might be cut off in the future, ordered experiments to develop a domestic substitute.

Through this research, an activated charcoal has been produced from sawdust, wood, coke, and even coal which is superior to that made from coconut shells in its ability to absorb toxic gases. Experiments are being continued by the Chemical Warfare Service to bring about still further improvement.

### New Naval Ordnance

THE Navy, of course, has also been actively engaged in developing new weapons for our sea forces. Rear Adm. W. H. P. Blandy, Chief of the Navy's Bureau of Ordnance, recently assured the country that we have new secret weapons, some "fully comparable to the German radio-controlled bomb and acoustic homing torpedoes," others even more amazing. Moreover, these weapons have been in use for "many months," said Admiral Blandy.

The new weapons are truly secret, known neither to the American public nor to the enemy. This latter situation was made possible by the fact that when a navy loses a weapon it usually goes to the bottom of the ocean where the enemy can't capture and imitate it.

"We have one development," Admiral Blandy said, "that certain foreign scientists labeled impossible, but I can't even disclose its nature."

He emphasized the enormous increase in ordnance production as well as the development of new weapons. As an example, he said the increase in production of torpedoes since the start of the war was 4,000 per cent.

### Recent German Weapons

THE Germans likewise have been engaged in trying to develop new weapons to stem the ever-increasing onslaught of the United Nations. While some improvements and innovations have resulted, no real "secret weapon" is known to have been used against the allied forces to date. However, some new defensive weapons have been used by the Germans in their attempt to stop precision bombing of Nazi industry. Some of these may be the defensive weapons referred to in Hitler's speech when he said weapons are being developed which would prevent the

## Professional Digest

bombing of Germany. They include rocket guns, aërial bombs, and "silver fire."

Rocket guns actually are being used in two ways against bombers—as ground defense and as aërial defense. On the ground, the rocket principle has been adapted to antiaircraft fire, providing a means for projecting a powerful shell to extremely high altitudes. In the air, the rocket principle apparently has been adapted to armament of interceptor planes. Rocket guns, or rocket propellants, have been seen on ME-109's and 110's and on JU-88's. The rocket cylinders are attached under the wings in addition to the normal armament of cannon and machine guns.

These uses of rocket guns are not new, except in application, as rocket guns now are veterans of ground warfare. The Russians reportedly have achieved success with rocket guns fired from low-level fighters against tanks and other ground installations. Hitherto, however, the rockets always have been used by ground forces against similar targets or by aircraft against ground objectives. The Germans now apparently have added the use of rockets for ground-versus-air and air-versus-air targets.

Use of rockets on planes is a natural development of the constant search for weapons which will send heavier projectiles a greater distance and, especially in the case of air ordnance, which will mean less load and less recoil. The particular benefit to Germany in the successful use of rocket guns on planes would be the possibility of overcoming the staying power of American bombers and of decreasing the heavy losses from the bombers' firepower. The present tactic is for German planes to stay outside the fire range of the bombers and lob rockets at the formation. If the same accuracy could be achieved with rockets as with guns and cannons now in use, which frequently make sieves of the bombers without knocking them from the air, the more explosive shell could knock down many more bombers with the same percentage of hits. This accuracy has not been achieved.

In addition, German planes hovering far above the bombers have dropped aërial bombs equipped with time fuzes. They also have tried the tactic of dive bombing American formations, releasing the bomb while still out of range of the bombers' guns, with the momentum and gravity carrying the bomb toward the formation. The bombs may be exploded by a time fuze or by an aneroid-activated fuze which explodes the bomb when it falls to a given altitude.

On one recent raid, Fortress crews reported massed clusters of "silver fire" which fell in front of the formation. One cluster struck a Fort and the burning material set the plane afire. The clusters are of white discs, probably of phosphorus.

Use of remotely controlled glide bombs against aircraft has not been reported to date, although such use against surface targets has been reported. These actually are gliders remotely controlled as to direction and have impact fuzes as do other bombs. Some have been reported with rocket propulsion. They have a relatively small wing area with extremely high wing loading and hence do no real gliding. Direction of fall (or glide) is, however, changeable by means of radio-operated control surfaces, but the directing airplane must keep the glider bomb between the target and itself and also must have a clear view of the target. Since it must fly an even course while directing the bomb, it becomes vulnerable to antiaircraft fire and to attack by fighter planes.

Another new German weapon, a rocket gun, weighs less than 1,800 pounds; yet it has a firepower equal to 6 heavy field howitzers weighing 9 tons apiece. German 62-ton Tiger tanks first used in North Africa are now appearing in increasing numbers on the Italian mainland and on the Russian front. There are also a number of new heavy self-propelled guns which have been identified both on the Russian front and on guard over the defenses of Hitler's European fortress.

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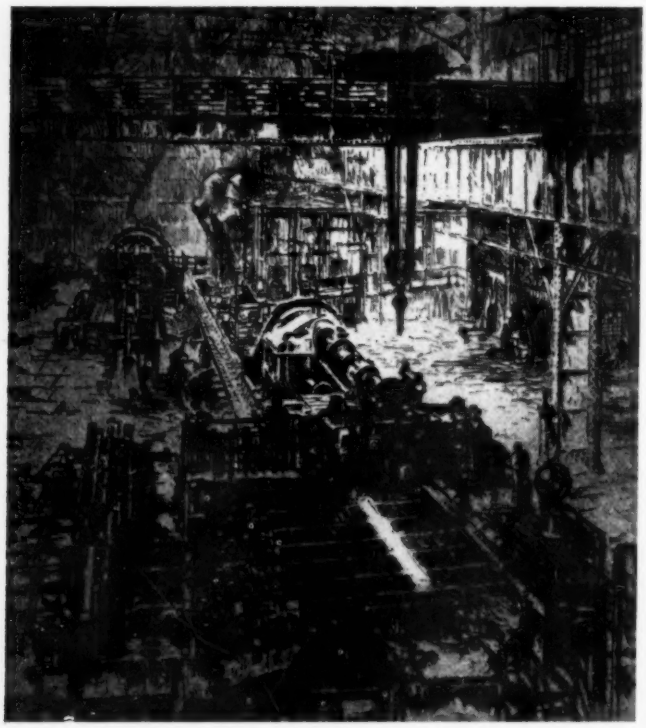

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# Ordnance Inspection

## An Electronic Method of Testing 20-mm. Shell

Capt. Emmons S. Lombard

THE device known as the "Sonotest," now used for acceptance testing of 20-mm. shell, originated from experiments in an attempt to find an automatic method of refusing bad coins and making change for bottled drink vending machines. It is an instrument which tests the quality of small objects by means of an analysis of sound waves generated by striking or dropping the

Front Panel of the Sonotest

objects to be tested. In measurements of sound waves, three things usually are considered: (1) the frequency of the sound wave, (2) the amplitude of the sound wave, and (3) the duration of the sound.

The term "frequency" is used to express the number of vibrations a second the object is undergoing after having been physically excited into vibration. Generally speaking, the greater the weight of an object, the fewer vibrations it is capable of undergoing in one second and, hence, the lower its frequency. The frequency is also governed to some extent by the physical shape, configuration, and the metal of which the object is made, which includes its elasticity, density, etc. Frequency is expressed in terms of the number of vibrations a second or, more commonly, in terms of cycles a second.

The term "amplitude" is used to denote the amount of sound that is being generated by one cycle of one particular frequency. An analogy between sound waves and the waves of an ocean may be helpful here. Assuming that five waves break upon the seashore every second, this would correspond to a sound wave having a frequency of five cycles a second. The height of each wave, if measured in any arbitrary unit of length, such as inches, feet, etc., would serve as a complete statement of the amplitude of each cycle of the ocean wave. In the realm of sound, any sound has a particular amplitude—the louder the sound, the greater the amplitude. For instance, if a key on a piano is struck gently, generally the sound produced would be of smaller amplitude than were the note struck with greater force. From this it can be seen that the amplitude of a sound is generally governed by the magnitude of the force creating the original physical excitation.

The difficulty in measuring the amplitude of a sound wave lies in the fact that it cannot be seen and hence cannot be measured by simple equipment, such as a measuring stick or scale, but must be measured in the terms of other units. There are, however, other ways of measuring the amplitude of a sound, such as

Captain Lombard is in charge of inspection of armor-piercing shot, Ammunition Branch, Ordnance Industrial Service.

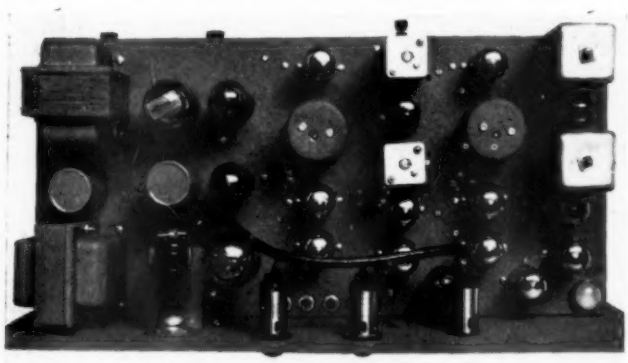
measuring the distance that a candle flame moves when sound waves are directed toward it, or by measuring the amount of voltage that a microphone produces from a given sound—the greater the voltage, the greater the amplitude.

One of the most useful and conventional methods of measurement is accomplished by noting the pressure of the air which the sound waves are disturbing. For example, a small ocean wave would disturb less air and create less pressure than a larger one, and the same condition is true for sound waves. Thus, the greater the air pressure coming from any sound generator, the greater the amplitude of that sound. The amplitude, when measured in terms of pressure, is usually expressed in terms of the amount of force being exerted on one particular area of air; *i.e.*, pounds per square inch or, in the metric system, dynes per square centimeter.

The term "duration" is used to express the time that elapses between the beginning of sound generation and the time that the sound has ceased to exist. It is usually measured in seconds or fractions of a second.

THE Sonotest instrument that is designed for inspecting 20-mm. shell measures, primarily, the frequency and the duration of the sound that is generated by dropping the shell upon an anvil. Inasmuch as the amplitude of the sound is governed by the force with which the shell is dropped on the anvil, the amplitude would seldom be the same since it is almost impossible for a person always to drop a shell with the same degree of force. In order to overcome this, the instrument incorporates an electronic control, termed a "limiter," that automatically adjusts the voltage coming from the microphone which, in amplitude, is in accordance with the amplitude of the sound it is picking up, so that this voltage always remains at the same value. This has the same result as always dropping a shell with one particular degree of force. This eliminates the human element inherent in the physical process of dropping a shell and allows the instrument to gauge accurately the two remaining measurements; namely, the frequency and the duration of the sound.

As a result of tests performed on thousands of shell, it was found that there was no particular frequency that could be used to describe all shell, but rather a group of frequencies—all centering about one frequency—was produced. This band of frequencies extended from 19,050 to 19,450 cycles per second, with 19,200 c.p.s. representing the center frequency of the band. This



A TOP VIEW OF THE TESTING DEVICE

band existed because the shell had certain physical and dimensional tolerances that changed the frequency of each shell according to an increase or decrease in these tolerances. This particular band of frequencies existed when the shell was bounced upon its base and therefore was termed the "base frequency."

Another band of frequencies was found to be necessary to describe the sounds that were produced when the shell was dropped on its side or nose. This band existed for reasons identical with those for the base frequencies. This band was termed the "side frequency" and was found to extend from 21,350 to 22,450 cycles per second, with 21,900 c.p.s. representing the

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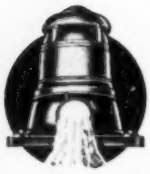

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## Ordnance Inspection

center of the band. The shell that were employed in these tests varied from the low to the high limits of physical tolerance in practically all dimensions. Since the frequencies they produced differed according to the dimensional variations, it was found that a shell generating a frequency beyond either one of these two bands must have one or more of its dimensions beyond the limits of physical tolerance.

In order to reject these shell, the instrument employs a set of electronic circuits that perform several unique operations upon the voltage representing the frequency of the particular shell under investigation.

THE accuracy of the instrument in rejecting shell of incorrect physical dimensions must depend upon its ability to discriminate sharply between the frequency that marks the edge of both the side and base bands and frequencies that are extremely close to the edge of the bands. For example, a shell with a base frequency of 19,040 cycles per second or, similarly, a shell with a side frequency of 21,340 c.p.s. should, by virtue of being outside the established band, be rejected.

The accuracy of the instrument in rejecting shell of incorrect physical dimensions must depend upon the ability of the instrument to maintain its original setting despite changes that might occur in the operating temperature of its component parts as well as in the characteristics of the tubes and the voltage supply. This is especially true under conditions of continuous operation over long periods of time.

In considering the solution of the first problem—that of accurate selection—let us consider two frequencies that are very close to each other; for instance, the frequencies 19,040 and 19,050 cycles per second. The difference between these two frequencies is 10 c.p.s., a difference that would, under practical field conditions, be quite difficult to detect. If, however, we multiply each frequency by 10, thus producing frequencies of 190,400 and 190,500 c.p.s., we now find that these frequencies differ by 100 c.p.s. Not only has the difference become greater, and thus easier to detect, but also the original frequency has been changed from one generally considered to be that of sound waves to a frequency that is considered to be that of a radio wave. The process of frequency multiplication is termed "harmonic generation," while the electronic tubes and associated circuits that actually accomplish this are termed an "harmonic generator."

An harmonic generator offers several other unique advantages: First, it is easier and more economical to obtain the necessary high-grade electrical component at the radio frequency that is finally produced than is possible at the original low frequencies; secondly, by proper designing of the circuit that actually does the frequency multiplying, it is possible to multiply an original frequency almost any number of times desired. This method makes it possible to utilize the identical radio components that exist in the 20-mm.-shell-testing instrument for projects in which different sound frequencies are employed, the sole requirement being that the original frequencies always be multiplied a suitable number of times in order to make the final frequencies come within the approximate range of the final frequencies in the 20-mm.-shell unit. Needless to say, this represents a tremendous reduction in the difficulty of procuring critical metal as well as a great saving in engineering time.

IN regard to the second problem—that of maintaining accuracy—the effects of temperature and age are easier to minimize at the radio frequencies. This is possible because radio-frequency components are simpler in construction and smaller in size than similar components designed for low-frequency operation. In addition, the voltages placed upon the tubes, as well as the tubes themselves and their associated circuits, are designed and produced so as to be rendered almost completely independent of moderately large charges. For example, the line voltage to the

## Ordnance Inspection

instrument can change from 90 to 140 volts, a change of approximately 64 per cent, while the accuracy of the instrument is changed less than one-tenth of one per cent. Likewise, interchanging new tubes with those having had several months of continuous wear has no measurable effect upon accuracy. Temperature changes of from 34 to 140 degrees Fahrenheit have shown a change of less than one-tenth of one per cent in over-all accuracy.

The frequency and amplitude of the sound having been considered, the remaining problem is that of duration. After extensive tests, it was found that 20-mm. shell of correct physical dimensions generated a sound that persisted for approximately 0.01 second, but this was true only if the shell was not cracked or if its attached copper band was securely seated to the body of the shell. The slightest looseness of the copper band or the slightest crack in the shell itself was sufficient to reduce the duration of the time to one-half of the original period or, in some instances, to one-tenth of the original time. The sensitivity of this measurement may be made more vivid when it is realized that the difference in physical bond between a slightly loose copper band and a tight copper band can be seen only under a microscope that magnifies at least five times. The electrical circuit that times the duration of the sound is termed a "time-delay network" and derives its name from its peculiar characteristic of being incapable of transmitting impulses that are shorter than some predetermined time.

THE operation of the Sonotest instrument itself now may be briefly summarized as follows:

(1) The base frequency of the 20-mm. shell is first produced by dropping the shell, base end, upon the anvil. (2) The frequency produced is picked up by a microphone. (3) The amplitude of the sound produced is then automatically set to a fixed amplitude by means of a limiter. (4) The frequency is then multiplied by means of an harmonic generator. (5) The frequencies falling within the band width are passed on to the time-delay network, and all others are rejected. (6) The duration of the sound is then measured in a time-delay network, and, if the duration is greater than a certain fixed minimum time, a light is illuminated on the front panel of the instrument. (7) The shell is then bounced upon its side and goes through an identical process of limiting, frequency multiplication, and duration measurement. (8) If the shell has had the necessary qualities to pass through the last test, a second light is illuminated on the front panel. (9) When both small lights are illuminated, and only then, a large green or master indicator light flashes, this indicating a good shell. (10) The small indicating lamps permit an analysis of defects in the shell by showing whether the frequency or the duration is incorrect.

The Sonotest instrument is a portable device weighing 70 pounds, its dimensions being approximately one foot by one foot by two feet. It operates on a regular 110-volt A.C. 60-cycle circuit.

It is a relatively simple matter to train the average girl to operate a Sonotest. After an hour's instruction, and one day of practicing the technique of bouncing the base and side of each shell on the anvil, the operator should be able to inspect 1,200 to 1,800 shell an hour. When the green master indicator light goes on, the operator knows the shell is acceptable, and when this light does not go on she knows the shell is rejected. One-hundred per cent inspection is practical and economical with the Sonotest.

The first test inspects, primarily, for loose rotating bands, loose base plates, and cracks, while the second, or side test, primarily checks for deep cavities, deep counterbore of fuze thread, torn threads, no threads, and cracks. This instrument will definitely pick out cracks that have depth or cracks that are completely through one side of the shell. Hairline seams which have depth of less than 0.020 of an inch are accepted, due to such a large tolerance on the required counterbore of the fuze thread.

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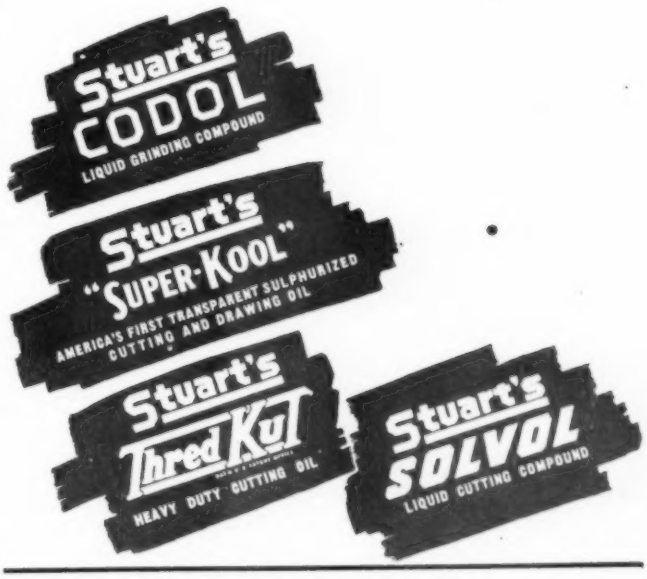


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## Book Reviews

THE SHARPS RIFLE. By Winston O. Smith. New York: William Morrow & Company. 137 pp. $3.

MR. SMITH, who, as far as this reviewer can recall, is a newcomer in the field of arms writers, has done a splendid job in this little volume of seven short chapters, amplified by several interesting appendices, a useful bibliography, and a good alphabetical index. The various Sharps rifle (and pistol) patents, the companies which exploited these, and the models in which the rifles were produced, are carefully and comprehensively recorded. By the addition of an identification chart (pp. 68-69) which lists certain outstanding characteristics to be looked for, it becomes possible for the lay student of small arms to identify practically any model Sharps percussion shoulder weapon which may fall into his hands. To any one not already an authority on Sharps products, this chart is worth the price of the book.

The volume is excellently illustrated with half-tones and line drawings which add tremendously to its interest and value. A fascinating chapter is devoted to the subject of ammunition for Sharps rifles, both the combustible linen-cased types and the metallic-cartridge variety. The modern devotee of the percussion rifle is supplied detailed information on how to "roll his own" paper cartridges, cast the bullets for these, etc. The list and description of metallic cartridges appears complete except for the .45-120-550 with 3¼-inch case. This happens to be the type today most sought by cartridge collectors, commanding for a single specimen a figure in dollars rather than in cents. It should be included in the ammunition table in any future edition.

Regrettable also is the omission of any detailed information about Sharps pistols. The 4-shot, metallic-cartridge types are barely mentioned. The single-shot percussion models—now prized by collectors as among the rarest and most desirable Sharps items—are, unless this reviewer's eye is faulty, completely passed over. However, the title of the volume is "The Sharps *Rifle*"—so perhaps we cannot blame Mr. Smith for adhering literally to his stated subject.

The reviewer respectfully suggests that Mr. Smith direct attention to a number of other American-made weapons the histories of which have never been written. Arms lovers should be most grateful to him for his present contribution. They will have further reason for gratitude if he will undertake to close more of the gaps still existing in American arms history. C. G.

THE PSYCHOLOGY OF MILITARY LEADERSHIP. By Pennington, Hough, and Case. New York: Prentice-Hall, Inc. 288 pp.

THIS book is one of Prentice-Hall's "Psychology" series. The authors are L. A. Pennington, a psychology professor; the late Lieut. Col. R. B. Hough, Jr., former librarian at the Army War College; and H. W. Case, personnel manager for an aircraft plant. Although the book was prepared primarily for use by newly commissioned officers to assist them in a rapid orientation to their new duties, undoubtedly much value may be obtained from its pages by all officers. It is based on the correct premise that an officer must be able to get along with and control his subordinates while at same time he is required to carry out the instructions of his superiors efficiently. The material is presented by discussing typical problems frequently encountered by officers and the psychological aspects of these problems.

After a brief introduction to military psychology, there are chapters on the officer as a student, instructor, leader, disciplinarian, and a personnel technician. The book ends with chapters showing the relationship between the officer and his men in battle, and between the officer and Army morale. B. B. A.

THE BATTLE IS THE PAY-OFF. By Capt. Ralph Ingersoll. New York: Harcourt, Brace & Company. 217 pp. $2.

THIS is the personal account of a newspaper editor who disliked the idea of changing into a soldier and who became so sorry about himself and his "treatment" in the Army that he was sure he would have to do something about it. What he did was to recognize the fact that he was in the Army, and that there was no middle ground on which he could labor. Finally, he ceased making himself unhappy, and also ceased being a journalist, and made himself fit for the job confronting him as a soldier.

This reviewer would like to see at least the preface to this book in the hands of every man who is now, or later may be, a member of our Army; if possible he should read the entire book to learn how to become a good soldier and how to get the most out of his life in the Army. F. H. W.

JAPAN FIGHTS FOR ASIA. By John Goette. New York: Harcourt, Brace & Company. 248 pp. $2.50.

MR. GOETTE, whose first-hand acquaintance with Japan's current military program dates from 1937, has produced an excellent account of how this has been evolved and how it has achieved the success with which it has so largely been crowned. He makes it plain that although our stake in the Far East is much less extensive than that of many a European nation, we shall have to join with them in the solution of the Asiatic problem after victory is won. He writes:

"Therein lies the danger of disillusionment both for the American people and for the masses of Asia. The latter already look upon us as committed to bring them freedom. If we fail to do that, and I cannot see how we alone can achieve it, then in their disappointment these Asiatics will turn against us. This will wound the feelings of Americans, who simply and honestly believe that we are crusading as 'forces of liberation.' . . . Whether they are British, Dutch, or Japanese bayonets, Asia does not like them. For the moment she looks to America as the 'force of liberation.' For the sake of our own people, if for no other reason, let us make no further commitments in regard to Asia until and unless we can insist that they be carried through. Let us do everything possible to save Americans and Asiatics alike from bitter disillusionment. After that, the question of what to do with . . . Japan will be much simpler." C. G.

PEOPLE'S WORLD. By A. Gordon Melvin. New York: John Day Company. 115 pp. $1.50.

THIS is a discussion of postwar expectations as they pertain to individuals. Freedom is fundamental, and freedom from want means that every one should have enough food. Free food for all is contrary to our national thinking, but the author's analogy of free water for all, which is not destructive of initiative, provokes one to think that our natural prejudices in this and other things may be wrong. He links rights with responsibilities to be fair, upright, courageous, and considerate. This small book forces the reader to contemplate the future wistfully and to wonder what the "people's world" will be like tomorrow. T. K. V.

OUR ARMY TODAY. By Kendall Banning. New York: Funk & Wagnalls Company. 320 pp. $2.50.

THE author, who did such a fine job in writing "West Point Today" and "Annapolis Today," has done equally well with this subject. Confronted with the usual censorship on items of military interest, he has presented the most complete picture of the soldier—who is your boy and my boy—from induction through training and into combat. Hundreds of anecdotes, brilliant humor as expressed only by the men of arms, human interest, and facts are here. It is delightful reading for one with casual interest—and will make you live with your soldier if you have one of your own in the service. T. K. V.

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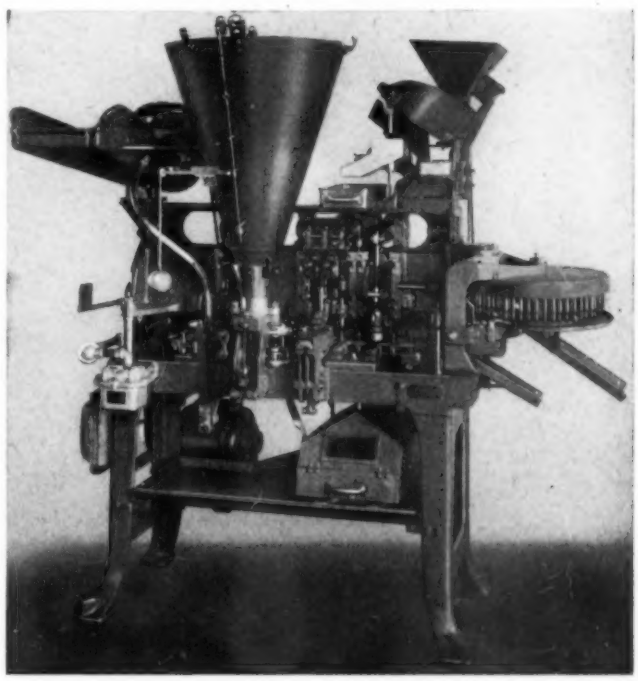

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BLOOD FOR THE EMPEROR. By Walter B. Clausen. New York: D. Appleton-Century Company. 341 pp. $3.

THIS is not just another book by another war correspondent. It unfolds in considerable detail and in extremely readable form the whole pattern of Japan's plan for conquest first of China and then of most of the remainder of the Eastern Hemisphere. Mr. Clausen makes it plain that the frustration of this plan will not be easy to accomplish. Time, as he points out, is the ally of Japan. The longer we refrain from an all-out effort against her, the better she will be able to resist that effort when it comes.

Meantime we can be doing something about the situation, at any rate. In short, we can be vigorously applying Admiral Halsey's formula for victory as quoted by Mr. Clausen: "Kill Japs! Kill Japs! Kill more Japs! Sink ships! Sink ships! Sink more ships!" C. G.

STUDIES ON WAR. Washington: The Infantry Journal. 158 pp.

A SERIES of essays by various authors on war as conducted by the "great masters," the economics of war, and the effects of geography on the human race. Well worth reading. F. H. W.

KILL OR GET KILLED. By Maj. Rex Applegate. Harrisburg: Military Service Publishing Company. 175 pp. $2.

THIS book covers the battle lore of tooth and claw. Its aim is to teach the soldier how to kick his adversary in the teeth—as well as anywhere else. The author teaches the fact that hand-to-hand combat has but one objective, and that is to kill in order to win. There are no Marquis of Queensberry rules to govern the combat. No holds are barred, nor are fouls considered, and there is no referee or umpire present. The formula for success in such combat is to be speedy and brutal; to hit your adversary when he's down, and then kick him; to attack with the hand, fist, edge of hand, gouging finger, club, knife, or looped wire garrote. The book is profusely illustrated, and its lessons will be of inestimable assistance to those who must fight barbarians with barbarity. F. H. W.

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### TECHNICAL MANUALS

*Manual for Instruction in Military Maps and Aërial Photographs.* By Norman F. Maclean and Everett C. Olson. New York: Harper & Brothers. 138 pp. $1.75.

*Surprise.* By Gen. Waldemer Erfurth. Translated from the German by Dr. Stefan T. Possany, Institute of Advanced Study, Princeton, and Daniel Vilfroy, an officer of the French Army on duty with the French Military Mission in Washington.

*Combat Aviation.* By Keith Ayling. Harrisburg: Military Service Publishing Company.

These three recent publications are manna for the armchair strategists. With the war winging its way toward global offensives, the public has a natural craving for information to assist in following the world-wide strategy and the tactical developments on the many fronts where action is constantly unfolding. The three books listed above are, however, more than reading for the layman; they are also textbooks for the serious student, both in and out of the armed services, who will welcome an opportunity to obtain factual information on the military art in a most convenient form.

The Manual for Instruction in Military Maps and Aërial Photographs outlines a basic course of instruction, designed for use of both instructor and student, covering what every soldier should know about reading maps and aërial photographs, regardless of the branch of service to which he may be assigned. It is so simply arranged that it presents an ideal preinduction course which will relieve the inductee of many bad hours in camp. The use of selected photographs for study is a particularly

## Book Reviews

valuable feature evolved out of long experience in teaching military map reading at the University of Chicago's well-known Institute of Military Studies.

The student who has a working knowledge of maps will naturally be interested in the application of the element of surprise to military operations. General Erfurth, a top-flight officer of the German Army assigned to the historical section of the German General Staff for "basic planning missions," prepared his book prior to World War II. His break with traditional military thinking on the use of surprise in war makes his work of special interest, because its conclusions were so clearly evident in the earlier stages of Hitler's European activities. The able translators have prepared an introduction which argues that strategic surprise is less likely than tactical surprise, and that surprise is easier with small forces. General Erfurth contends simply that "surprise is nothing but the application of the economy of force" and is the key to victory. In support of his theory, he reviews, adapts, and elaborates the principles of the earlier writers, and, instead of accepting the conception of surprise as a by-product of a tactical operation, he concludes that any force should "attack whenever the enemy is off guard." This principle, therefore, makes surprise applicable to strategical as well as to tactical operations. It is interesting to note that Hitler always succeeded in strategical surprise by making sure his "enemy was off guard" as a result of preparatory propaganda.

"Combat Aviation" fits neatly into this series because it shows how essential is a knowledge of maps and aërial photography in contributing to the application of surprise in the early development of any military or naval operation. Keith Ayling, who has written much on aviation topics, has produced an ideal guide and refresher for fighter pilots, and a book of great interest to all those who have a yearning to graduate for the most exciting job of all operational aviation. Written in a nontechnical style, the author high-lights the fundamentals of every type of aërial combat. He illustrates his points with stories of actual engagements, covering every phase of fighting, describing and discussing the possibilities of each type of fighter plane, and concluding that our experience in combat has turned our delay in development of aviation prior to the war to good account because we did not have a lot of outdated planes on hand. We are up to and ahead of the needs instead of limping along with a mass of fighter craft which cannot meet the new requirements.

It is seldom that three such interesting textbooks come along together to make a really instructive pattern of absorbing reading for both the layman and the student. R. M. C.

*Cellulose and Cellulose Derivatives.* Edited by Emil Ott, director of research, Hercules Powder Company. New York: Interscience Publishers, Inc. 1,176 pp.

This book is Volume V of a series of monographs on the chemistry, physics and technology of high polymeric substances. The subject matter was contributed by thirty-five authors, each one selected to cover a phase of the subject in which he is actively engaged and especially well versed. The scope of the material presented is broad and of necessity requires many pages for proper treatment. The book is an excellent compilation of the results of investigational work on the chemical, physico-chemical and technological aspects of cellulose and those derivatives of cellulose which are now of importance industrially.

The first seven chapters deal largely with cellulose, the complexes closely related chemically to it and associated with it in wood, cotton, and other natural sources of cellulose. The most important theories concerning the chemical nature and structure of cellulose are discussed and evaluated—the most complete summary of modern views on the subject which is known to the reviewer.

Those portions of the book dealing with industrial processes

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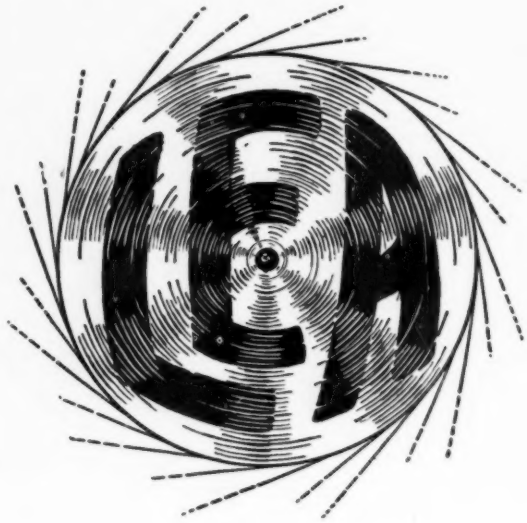

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## Book Reviews

involving cellulose or its derivatives emphasize the theoretical aspects of the processes, the chemical and physicochemical changes that occur in such operations as mercerization of cotton fabrics, beating and hydration of pulp for production of paper, bleaching and purification of cellulose from natural sources for various uses, the formation of esters, ethers, xanthates, etc. No attempt has been made to give details regarding manufacturing processes and equipment but rather to provide the fundamentals from a scientific standpoint back of all such processes, and this is admirably done. G. C. H.

*Salvage Manual for Industry.* Published by the War Production Board. Distributed by the Superintendent of Documents, Government Printing Office, Washington, D. C. 243 pp. $0.50.

To the industrial plant interested in furthering the war effort, this manual, just issued by the War Production Board, will be of practical assistance. It tells what to do, how to do it, cites Government regulations, and gives practical illustrations. Many businesses can save considerable sums of money by following the ideas outlined. It is necessary that conservation efforts be continued; therefore, all processors of material should utilize the information given in this manual. It is hoped that private industry will look beyond the war effort, realize that our natural resources are a national asset, and continue its conservation work in the postwar period. T. L.

*Encyclopædia of Substitutes and Synthetics.* Edited by Morris D. Schoengold. New York: Philosophical Library, Inc. $10.

The jacket cover describes this as "the first book of its kind in any language." No such claim really fits this book. It is modeled after the method and format of the well-known Chemical Dictionary, and its listings are identical in form with those of the Commodities Handbook of the National Association of Purchasing Agents. In too many cases it gives a suspicion of copying from other prepared texts, but has an obvious disadvantage over the materials handbooks in giving too much prominence to trade-named materials instead of using them merely as examples of the practical application of materials. Thus there is endless repetition of nonimportant advertising claims. There is also too much page space lost in an outmoded method of cross-indexing. The treatment of industrial raw materials does not indicate any considerable research into practical data. Typical of this is the description given for "Rouge" as follows: "A red pigment used as a polishing agent. It is claimed that a product named Chromitron is superior to this for the same purpose." The encyclopædic value of such descriptions and designations of substitutes is obviously nearly zero. The book is not to be recommended for serious technical usage. G. S. B.

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### Books Received

What You Should Know About the Army Ground Forces. By Col. Joseph I. Greene. New York: W. W. Norton & Company. 209 pp. $2.50.

Amateurs at War. Edited by Ben Ames Williams. Boston: Houghton-Mifflin Company, 494 pp. $3.

On Your Own. By Samuel A. Graham and Earl C. O'Roke. Minneapolis: University of Minnesota Press. 150 pp. $2.

The Military Stenographer. By Queena Hazelton. New York: McGraw-Hill Book Company. 133 pp. $1.

The Gun. By C. S. Forester. Washington: *The Infantry Journal.* Fighting Forces Series' special pocket edition made available to members of the armed services only.

English for the Armed Forces. By Lieut. Col. A. G. D. Wiles, Lieut. Arlin M. Cook, and Lieut. Jack Trevithick. New York: Harper & Brothers. 252 pp.